State of Maine

Department of Transportation
Bridge Plan Development Guide

Draft of March 2007

CHAPTER 1 INTRODUCTION

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1.2 General

1.2.1 Purpose

This guide has been developed to aid the draftsman, technician and engineer in the preparation of bridge structure contract documents.

1.2.2 Prerequisites

It is assumed that the audience is fluent in the graphic language of technical drawing, including geometric constructions, multi-view projections, sectional views, and dimensioning. This guide aids in the application of these skills to the specialized task of bridge working drawing preparation.

1.2.3 Contract Documents

Working drawings are one component of the contract document package (construction plans, *Standard Details* and *Standard Specifications*) required to describe the project. The detailer must be familiar with all three components so that the drawings properly describe the project, complementing without duplicating information presented elsewhere.

Bridge plans include site-civil details as well as structural details, and occasional utility details (conduit, lighting, etc.) Structures may be a minor element of a much larger highway project, which will require coordination with a second design group. They may include limited approach work with the structure details. They may be a simple rehab of a small portion of a structure.

1.2.4 Explicit vs. Performance-Based Detailing

The Detailer is asked to provide different types of details depending on the requirements of the project.

1.2.4.1 Explicit Detailing

In explicit detailing, the Detailer is providing all the information required to fabricate and erect a structure. Often, these details need to be used in conjunction with the *Standard Details*, which will provide additional information about common structures.

Examples: Abutments, CIP Walls, Structural Steel, Expansion Joints

1.2.4.2 Performance-Based Detailing

In performance-based detailing, the Detailer is providing geometry and design constraints for an element to be designed by others. Typically this means diagrammatic representations of the structural element.

Examples: T-Wall, MSE Walls

1.2.5 Clients

The details provided on the plans are used in different ways by different clients, and some details serve the needs of one more than another. The three potential clients are:

1) **Designer:** performance-based detailing is providing information to a Designer who will be working out the explicit details of the structure.
2) **Fabricator:** many explicit details provide information to the Fabricator, who is responsible for the manufacture of the elements of the structure. Examples of details for use by the fabricator would be: camber diagrams, stress-type diagrams, precast plans and sections, reinforcing steel schedules.
3) **Contractor:** many explicit and performance-based details provide information to the Contractor to assist in the erection of the structure. The Contractor needs to know how and where to assemble all fabricated elements. The Contractor is also responsible for the CIP concrete.

1.3 Plan Development Process

1.3.1 Overview

The development of working drawings occurs during two stages of the project development process: preliminary and final design.

Preliminary design documents communicate the design intent to the team and other agencies and provide a permanent record of the preliminary design process.

Final design drawings communicate to the general contractor and the fabricators:

a. Where the structure is physically located in space,

b. The construction of the individual elements of the structure (beams, piles, concrete structures, miscellaneous metals, etc.).

c. How each element fits into the whole.

d. Payment methods for all elements

1.3.2 Plan Development Checkpoint Process

The following process is based on internal MaineDOT procedures and modified to include consultant-oriented checkpoints and further differentiation that should help the detailer get perspective on where their specific jobs and responsibilities fit into the overall process.

1) Project Kickoff
2) Team organized
3) Team compiles preliminary data
4) Initial team meeting/point of communication
5) Preliminary public meeting
6) Begin preliminary design
7) Develop alternate horizontal and vertical alignments
8) Develop preliminary toes of slope/impacts for alternate alignments
9) Horizontal/vertical alignment OK by team
10) Finalize PDR
11) Prepare PDR preliminary plan and profile
12) PDR/ Preliminary plan OK by team
13) Formal public contact
14) Midway team meeting/point of communication
15) Begin Approaches and Final Structural Design
16) Finalize General Plan, Profile, Cross-Sections, Geometry (Approach Design).
17) Bridge approach plans OK by team and Checker (or “Impacts Complete”)

18) On structures with complex substructure geometry, Prepare 30% bridge plans depicting the general structural features including concrete outlines, superstructure plan, and section prior to designing reinforcing steel.
19) 30% plan review by team
20) Structure geometry check and Final design.
21) Finalize plan details and develop reinforcement for concrete elements.
22) Distribute 80% construction plans (with estimate items but no quantities.)
23) Check the final details.
24) 80% plans OK by team
25) Final Engineers Estimate
26) Engineers Estimate Checking
27) Package to contracts
28) Final contract document review.
29) Advertise & Award
30) Construction
31) Final team meeting/point of communication

1.4 Plan Set Organization

The following lists are intended to clarify the order in which plans should be presented in a plan set. Refer to further chapters for information about the contents of these plans.

1.4.1 Preliminary Plans

1) Plan
2) Profile
3) Additional Details

1.4.2 Final Plans

1) Title Sheet
2) Estimate & Notes
3) General Plan(s)
4) Profile(s)
5) Boring Location Plan and Interpretive Subsurface Profile
6) Boring Logs
7) Additional Geometry Sheets (Curb, Intersection, etc., if req'd)
8) Guardrail Layout (if req'd)
9) Cross Sections
10) Staged Construction
11) Abutments
12) Retaining Walls
13) Piers
14) Framing (Structural support layout for superstructure)
15) Framing Details
16) Superstructure (Interaction of structural support with deck)
17) Superstructure Details
18) Rail Details
19) Reinforcing Steel Schedule
20) Utility Details
21) Property Map

1.4.3 Border Information

Each sheet needs to contain the following information:

1) Sheet number(s)
2) PIN & Project numbers
3) Bridge number
4) Title block (Preliminary Plan)
5) Personnel names or initial

CHAPTER 2 APPROACHES

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2.2 Alignment and Layout (Preliminary Design Support)

2.2.1 Introduction

The “Alignment” of a project is defined as “The baseline for construction of a bridge and its approach roadway, described horizontally by a series of tangents and circular arcs, and vertically by a series of tangents and parabolic curves.”

The Alignment is established by strict geometric criteria that allow it to be laid out in the field.

This alignment is also known as the Centerline of Construction. This line is the geometric backbone of the project. Each element to be constructed in the field is located relative to this alignment.

The starting point of an alignment is assigned a particular “Station” value, and each point along the alignment can be described by its Station. Refer to Figure 2-1 Stationing.

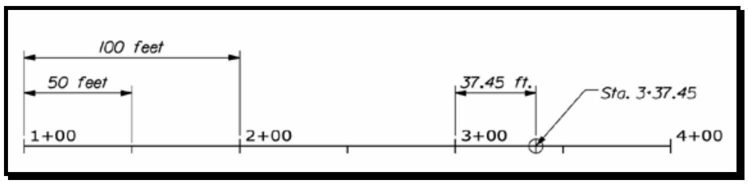

Figure 2-1 Stationing

The direction of increasing station values along the centerline of construction is referred to as “UPSTATION.” Perpendicular directions are defined as left and right of the centerline of construction, looking upstation

Points off the alignment are located by their “offset” – a perpendicular distance to the alignment – and the station at which that perpendicular line intersects the alignment.

- “Alignment” is also a more general term that can be used to describe other features, i.e. the centerline of stream, the face of curb, or the rails of a railroad track. Alignments may also be defined for side roads. In general, however, references to the “Alignment” are referring to the Centerline of Construction.

Horizontal and vertical alignments are closely tied to the bridge size-type study and maintenance of traffic considerations. Multiple alignments are commonly developed to address the range of project constraints resulting from the variability of structure type (pipe arches vs. box culverts, two span box beam vs. simple span NE Bulb Tee for example), stage construction configurations, property, and environmental constraints.

Work with a designer to plan out the alignments. In many cases you’ll simply be matching an existing alignment. When you aren’t matching the existing, the designer will offer input as to how the alignment needs to be different from the existing alignment. The technician will work closely with the designer through iterations of the alignment options.

2.2.2 Horizontal

A horizontal alignment has two components, straight lines and curves. The straight lines or tangents are connected by curves, either simple, compound or reverse.

Where two tangents are extended they meet at a point called a PI or Point of Intersection. Each tangent of the alignment is described by its bearing direction.

The circular curve is tangent to the two straight lines adjacent to the curve. Each curve is described by its radius, as well as the Station where the curve begins (PC or Point of Curvature) and ends (PT, or Point of Tangency.)

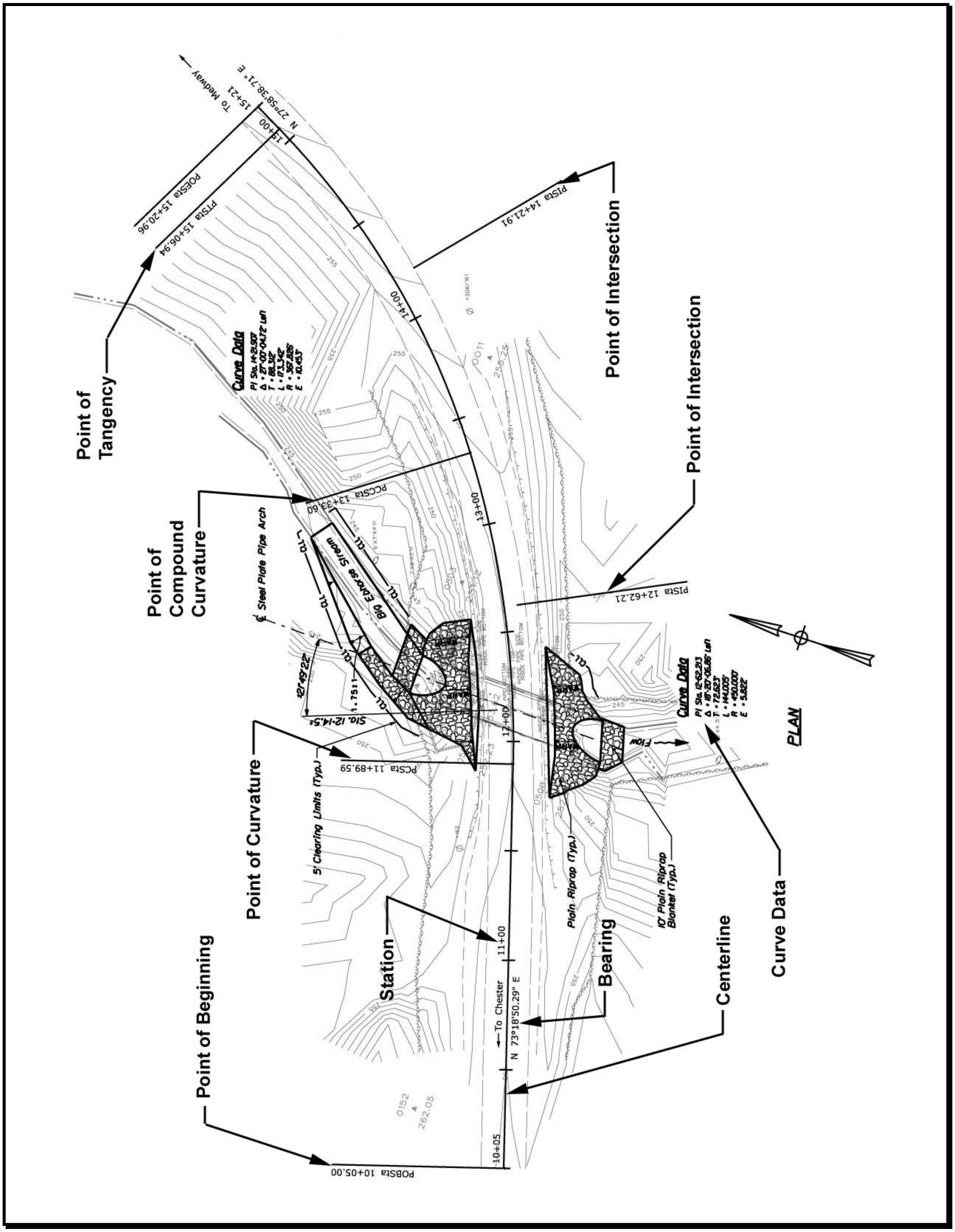

Figure 2-2 Anatomy of a Horizontal Alignment

2.2.3 Vertical

A vertical curve has the same two components as the horizontal alignment.

It starts as a series of lines. Lines meet at a PVI, or Point of Vertical Intersection. These lines are described by their station and grade.

The PVIs are then rounded by vertical curves. Unlike horizontal curves, vertical curves are parabolic, not circular. Vertical Curves are described by: the length of the curve, the point where the curve begins (PVC), and the point where the curve ends (PVT).

♬ PVC and PVT points should be established on even stations. Vertical curve data should stay within the project limits if possible.

2.2.4 Alignment Layout

There are many factors that influence the layout of the horizontal and vertical alignment. In general, the alignment needs to accommodate environmental, safety and right-of-way concerns while keeping a constant eye out for constructability issues.

2.2.4.1 Before You Start

You will need:

1) Survey
2) Approx. Length of Project
3) Horizontal and Vertical Limitations

2.2.4.2 Environment

It is necessary to gage the environmental impact of the new roadway. The most common impact to gage is where toes of slope may fall in wetlands. Additionally, toes of slope need to be evaluated against historic preservation concerns.

2.2.4.3 Safety

The location and radii of curves on an alignment have an impact on the overall safety of the project. These affect sight distance and design speed.

↳ Refer to the *Urban and Arterial Highway Design Guide, Bridge Design Guide* and *AASHTO Policy on Geometric Design of Highways and Streets* for more information.

2.2.4.4 Right-Of-Way

Alignments are often affected by ROW concerns. These may include impacts on private landowner's lawns, structures, trees, and drainage ways. Utilities can also impact ROW concerns.

2.2.4.5 Constructability

Many factors affect the constructability of an alignment. Alignments need to be designed to facilitate maintenance of traffic during the project. Consideration should be given to Staged Construction, temporary structures, on-site detours, etc.

2.2.5 Bridge Layout

When laying out bridge elements along an alignment, it is necessary to establish stations and skew angles for all elements of the substructure. This process varies slightly depending on the geometry of the alignment in the vicinity of the bridge.

2.2.5.1 Tangent Alignment

If the geometry near the bridge is a straight tangent as shown in Figure 2-3, the layout is fairly simple.

Layout for a bridge on a tangent alignment is established from the intersection of the centerline of bearing of each substructure unit with the centerline of construction. The station along the centerline of construction is given for each intersection. These intersections are used as the basis for all detailing of the structure.

- ♬ It is desirable to locate the substructures at some even Station.

The skew angle of a tangent bridge is defined as the angle between the centerline of bearing of the substructure unit and a line perpendicular to the centerline of construction at the intersection point. The skew angle is always indicated as back or ahead on the left side of the centerline of construction.

"HEAVY SKEW" is a term generally applied to skew angles greater than 30°, where special consideration is given to various structural details.

If a skew is required, each substructure element should be skewed by the same angle relative to the centerline of construction.

- ♬ It is also desirable to set the skew angle to an even number.

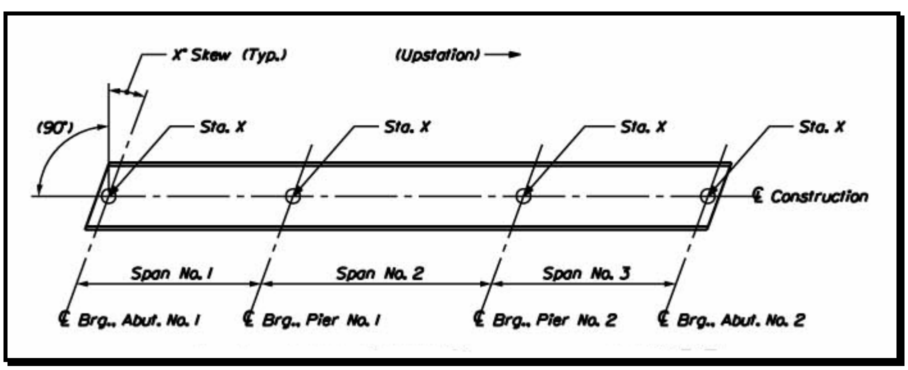

Figure 2-3 Layout of Bridge on a Tangent

2.2.5.2 Curved Alignment

Layout of a bridge along a curved alignment is more complicated. Refer to Figure 2-4 for guidance.

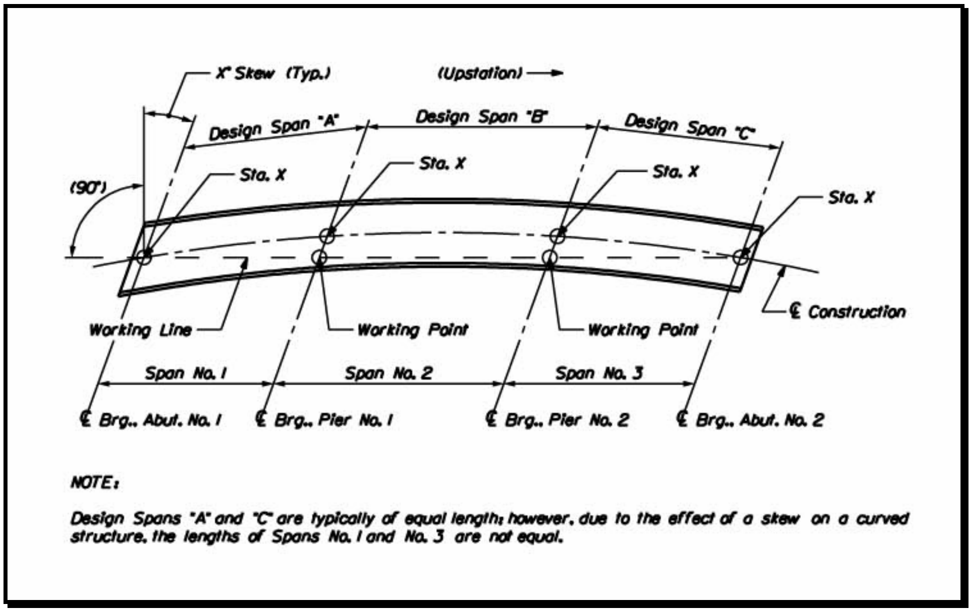

Figure 2-4 Layout of Bridge on a Curve

The first step of the layout is establishing a working line. The working line is a straight line running from Abutment 1 to Abutment 2. The working line crosses the centerline of construction and the centerlines of bearing of each abutment.

♬ Remember that the centerline of bearing of each abutment should cross the centerline of construction at some even Station.

The station along the centerline of construction is given for the intersection of the centerline of bearing of each substructure unit with the centerline of construction.

In addition, a "WORKING POINT" is established at the intersection of the centerline of bearing of each substructure unit with the working line. These working points are used as the basis for all detailing of the structure.

The skew angle of a curved bridge is defined as the angle between the center-line of bearing of the substructure unit and a line perpendicular to the working line at the intersection point. When the centerlines of bearing are 90° to the working line, a curved bridge has no skew.

2.2.5.3 Partial Curve

Layout out a bridge on a partial curve is similar to laying out a bridge on a tangent. Refer to Figure 2-5 for guidance.

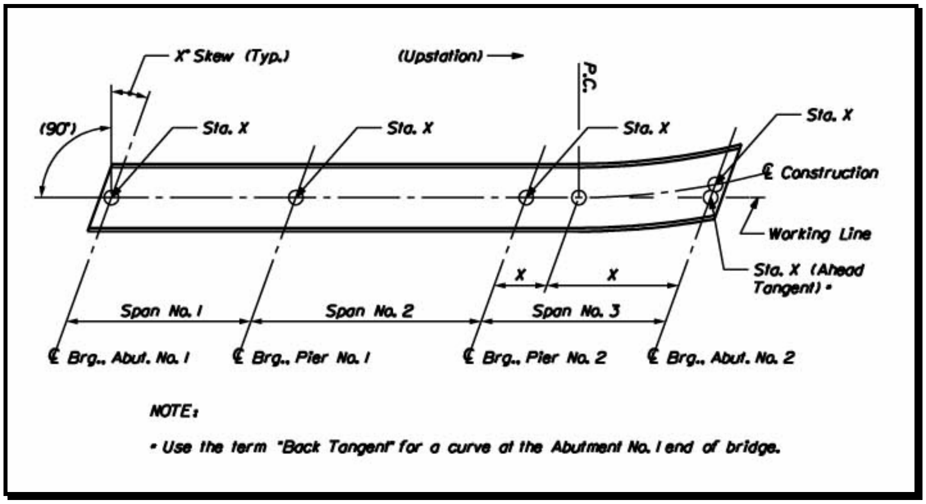

Figure 2-5 Layout of Bridge on a Partial Curve

Layout for a bridge on a partial curve is established by extending the tangent through the centerline of bearing of the abutment. This extended tangent becomes the working line for the curved portion of the structure.

A station is given for the intersection of the centerline of bearing of the substructure unit with the working line, calculated along the tangent extended back from the P.T. or ahead from the P.C. This station is labeled as "back tangent" or "ahead tangent" and becomes the working point. This working point is used as the basis for all detailing of the curved portion of the structure.

The skew angle of a partially curved bridge is referenced to the tangent / working line and is measured in the same manner as a fully tangent bridge

All substructures should be skewed to an even angle relative to this line.

2.2.5.4 Buried Structures

Layout for a buried structure is established from the intersection of the centerline of structure with the centerline of construction. The station along the centerline of construction is given for the intersection. This intersection is used as the basis for all detailing of the structure.

The skew angle of a buried structure is defined as the angle between the centerline of structure and a line perpendicular to the centerline of construction at the intersection point (Figure 2-6).

For a buried structure on a curved alignment, the skew angle is defined as the angle between the centerline of structure and a line perpendicular to the tangent to the centerline of construction at the intersection point (Figure 2-7.)

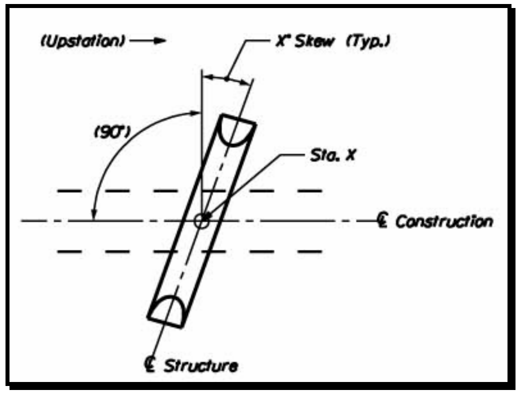

Figure 2-6 Layout of Culvert

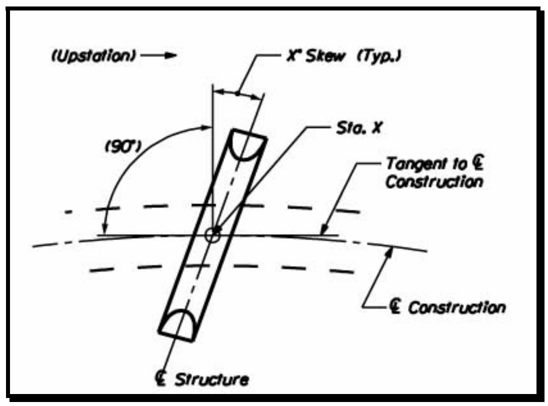

Figure 2-7 Layout of Culvert on Curve

2.3 Guardrail

Refer to the *Bridge Design Guide* Section 2.8.2 for complete information regarding guardrail design. The following is a brief punch list gathered from that information.

2.3.1 Function

To provide protection for traveling public

- Prevent vehicle from overturning on critical (steeper than 1:3) slopes
- Prevent collision with DFO (Deadly Fixed Object)
- Prevent vehicle from entering deep water

To lessen project fill slope impacts

- Limit Right of Way encroachment
- Minimize environmental issues (filling of wetlands)

2.3.2 Design Theory

Strength derived from continuous “ribbon” effect

Intended to deflect or “give” when hit

Intended to guide errant vehicle back into roadway

End treatments provided to prevent guardrail penetration into vehicle

2.3.3 Physical Characteristics

Standard 12.5’ panel lengths with 6.25’ post spacing

Panels may be field cut to match existing guardrail to remain

Install straight panels on curves with radius greater than 150’

Minimum curved guardrail radius of 10’

Various types are described in the *Standard Specifications*, Section 606

- Type 3 has steel beam with optional wood or steel posts
- Type 3b has steel posts only (use when embedding posts in concrete)
- Type 3d with wood or composite offset brackets is required on NHS

2.3.4 Layout

Use full 12.5’ panel lengths measured along the face of guardrail

Attachment to traditional bridge

- Provide 18.75’ “Bridge Transition Type 1”

- Work away from the structure in both directions

Give stationing normal to centerline of construction

Stationing along curves will not match actual guardrail lengths

All end treatments are 37.5' long with 4' flare

Berm flare is 10' from normal face of guardrail

2.3.5 Standard End Treatments

Selection criteria

- Highway classification
- Traffic volume

Options (From MaineDOT "Guardrail and GR Terminal Policy" dated July 8, 2003)

- Guardrail 350 Flared Terminal required on NHS
- MELT (Modified Eccentric Loader Terminal) for AADT ≥ 500
- Low Volume Guardrail End for AADT < 500

BDG allows LVGRE on trailing end with AADT < 1000

LVGRE preferred for roadways maintained by municipality

2.3.6 Considerations For Terminal Location

AASHTO Clear Zone requirements per *Highway Design Guide* and *BDG*

- NHS
- Major projects
- High traffic volumes / high speeds

Minimum guardrail lengths per *BDG* (doesn't include end treatment)

- Leading end desirable length of 100'
- Trailing end desirable length of 50'

Entrances

- For driveways use 25' at 15' radius with terminal end
- For side roads use applicable standard end treatment
- "Cable Releasing Terminal" available for higher level of protection

Least project impact

- Effect on ROW / wetlands
- Long 1:3 sideslopes at flare
- Ditching with long backslopes

Proximity of woods / brush

Existing guardrail conditions

- Guardrail may be extended beyond the project limits if necessary by rebuilding existing shoulders and establishing a "limit of shoulder work.

2.4 Preliminary Plans

2.4.1 Introduction

The Preliminary Design Report (or PDR) is the first major milestone in the plan development process. As a Detailer, you will be responsible for helping to develop the Preliminary Plans, a graphic representation of the written portion of the PDR. The Preliminary Plan is a proposed scope of work for a project (refer to the *Bridge Design Guide*, Chapter 2).

The plan will be shared with other departments and agencies (Environmental, MHPC, Army Corp of Engineers, Inland Fisheries and Wildlife, Department of Conservation, Property Office, Utilities) and with the public (towns, Indian Nations, etc.) for the purpose of gathering their feedback and input before proceeding with final design. This is why it is so important to be sure that any information showing impacts or boundaries for any of the interested parties is shown on the preliminary plan.

The preliminary plan usually consists of 2 or 3 separate sheets. The first sheet should contain a plan view of the project, notes and specifications, and a location map. The second sheet will typically contain a profile view, an approach section, and typical sections of the proposed and existing structure. If there isn't enough room for all that on two sheets, a third sheet can be added to accommodate overflow.

Occasionally a stage construction sheet will be required as well, if the project manager anticipates traffic issues being discussed at the public meeting.

2.4.2 Prerequisites

2.4.2.1 To Get Started

You will need to gather the following:

1) Horizontal and Vertical Alignments
2) Roadway width
3) Roadway Superelevation
4) Roadway Cross-slopes
5) Guardrail type and limits
6) Curb Type
7) Shoulder width
8) Subbase Depth
9) Fore slope
10) Back Slope
11) Ditch design
12) Structure size, type and location
13) Project Limits

14) Substructure Skew
15) Working Line
16) Survey (including existing utilities and existing structure)
17) Wetland Limits

2.4.2.2 To Finish Up

The following information needs to be assembled to finish the plans:

1) Maintenance of traffic plan (Temporary Detour, Staged Construction, etc.)
2) Drainage Design (Catch Basin Locations, Underdrain, etc.)
3) Traffic Data
4) Location Map
5) Horizontal and Vertical Alignment Data
6) Riprap Limits
7) Hydrologic Data
8) Specifications
9) Design Loading
10) Approximate Cost
11) Utilities List

2.4.3 Boundaries or Limits to be sure to show

1) Existing and Proposed Right of Way Lines
2) Wetland Limits
3) Contours
4) Clearing Limits
5) Sill Elevations
6) Historic or Archeologically significant area limits

2.4.4 Impacts to be sure to show

7) Toes of Slopes, Ditches, cuts, fills
8) Riprap
9) Drives
10) Recreational Access Design (extended guardrail flare/parking, walkways, canoe slips, etc.)
11) Temporary Bridge/Detour
12) Trees to be removed

13) Houses/Structures to be removed
14) Any other impacts to property (mail box, flower bed, well, septic system etc.)
15) Hazardous Material Areas
16) Utility moves/impacts
17) Subsurface Drainage impacts
18) Any other impacts to resources, property, traffic, utilities, etc.

2.4.5 Detailing

2.4.5.1 Workflow

The following workflow is provided to offer a brief perspective on one approach to detailing a preliminary design plan set.

1) Lay out roadway widths, shoulder widths and guardrail on plan view
2) Develop cross sections (cut sections that show existing ground)
3) Draw template (finish grade, subgrade) on cross sections at the correct elevation (refer to profile.)
4) Put sideslopes on cross sections
5) Transfer toes of slope from cross sections to plan
6) Draw bridge structure on plan
7) Finish toes of slope around the bridge
8) Draw riprap on plan
9) Complete the Profile
10) Create Preliminary Plan Archive
11) PDR/Preliminary Plan OK By Team
12) Formal Public Contact
13) Midway Team Meeting

2.4.6 Typical Sheet Names and Contents

2.4.6.1 Preliminary Plan

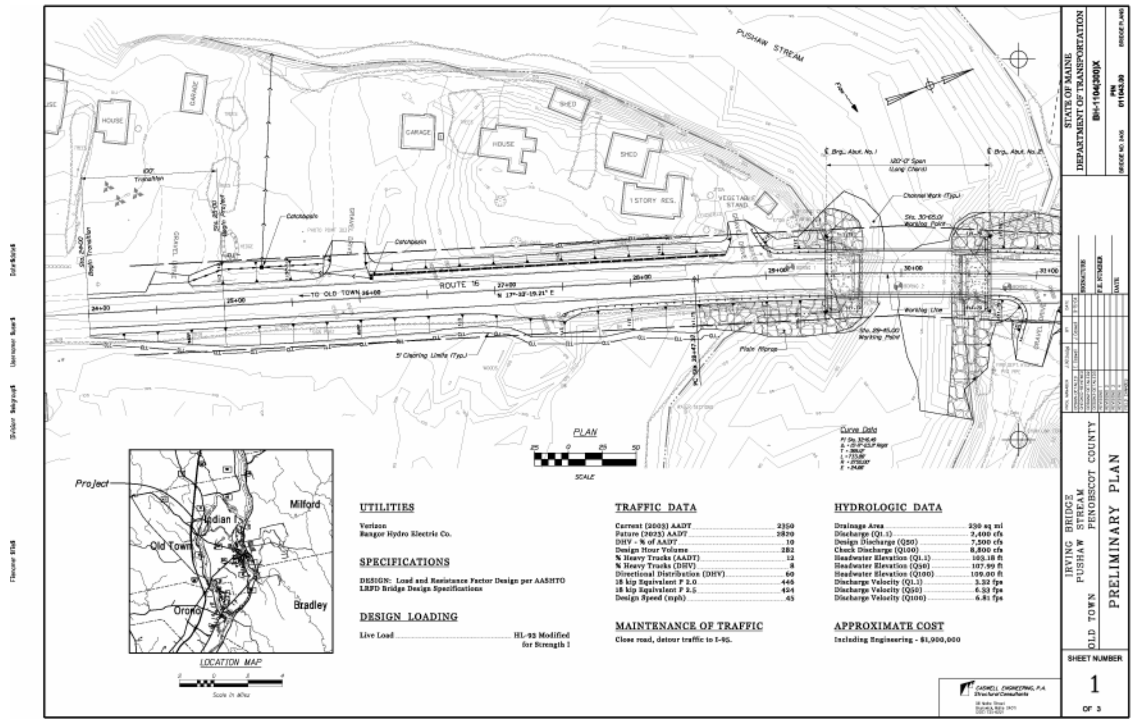

Figure 2-8 Preliminary Plan Sheet

Will Contain:

1) Plan
2) Datum Reference

May Contain:

♬ The Preliminary Plan Sheet is the preferred location for notes and location map.

1) Location Map
2) Scope of Work
3) Utilities List
4) Specifications
5) Maintenance of Traffic
6) Design Loading
7) Traffic Data
8) Approximate Cost
9) Hydrologic Data

10) Proposed Approach Section
11) Proposed Bridge Section
12) Existing Bridge Section

2.4.6.2 Preliminary Profile

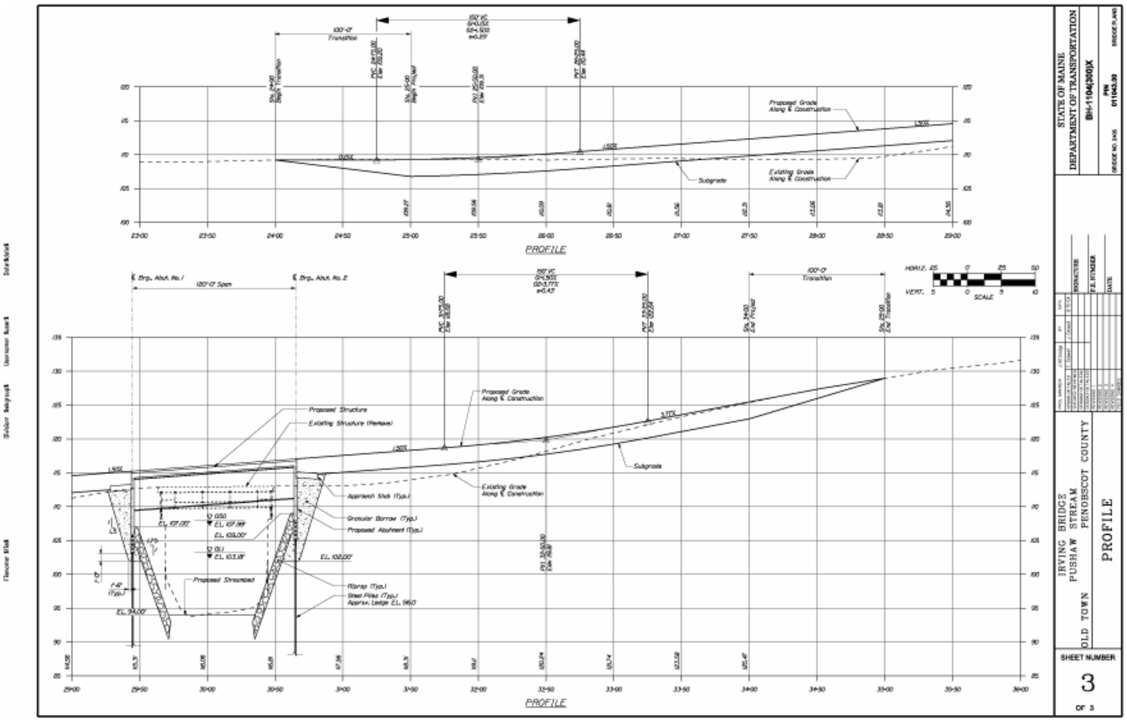

Figure 2-9 Preliminary Profile

Will Contain:

1) Profile

May Contain:

1) Proposed Approach Section
2) Proposed Bridge Section
3) Existing Bridge Section

2.4.6.3 Typical Sections (optional)

May Contain:

Refer to section 2.4.6.1. Any items not shown on the Preliminary Plan or the Preliminary Profile may be shown on a Typical Sections Sheet.

2.4.6.4 Staged Construction (optional)

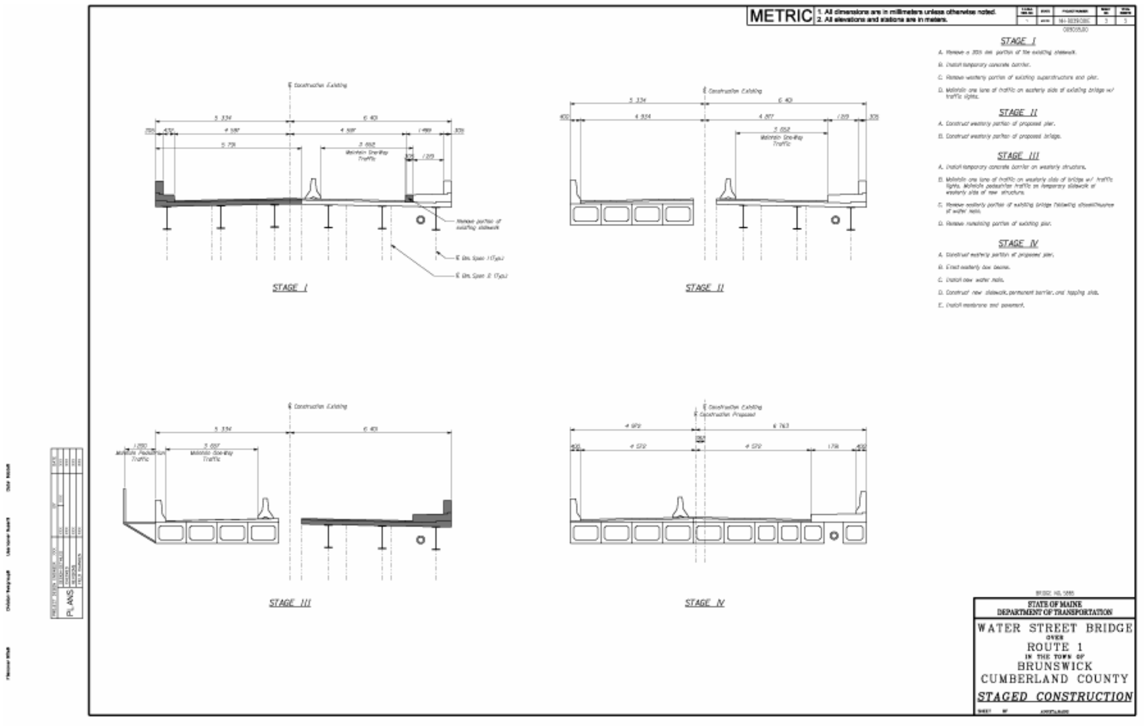

Figure 2-10 Preliminary Staged Construction Sheet

Will Contain:

Any and all notes, sections, details, and plans required to communicate stage construction intent.

↳ Refer to Chapter 7 for more information on Staged Construction

2.4.7 Detail Checklists

2.4.7.1 Plan

Intro: Top view of the project, intended to show roadway impacts and preliminary structure.

Sheet-up: The plan view is shown typically on the first sheet of the preliminary plan set.

Scale: 1"=25'

Draw/Show:

1) Centerline Construction Alignment with tick marks at full stations and 50' stations
2) PI locations with tangent extensions
3) CL Brg. Substructure
4) Limits of Superstructure and Substructure
5) Curb/Sidewalk and Rail on Superstructure

6) All proposed features (plain riprap, gabions, downspout, etc…)
7) Edge of Travelway
8) Guardrail
9) Berm
10) Toes of slope
11) Ditches with flow lines
12) Clearing Limits
13) Drives, paved aprons
14) End of Project limits
15) Temporary Detour w/ alignment, roadway limits and toes of slope (if req'd)
16) Contours
17) Topo / Survey
18) Wetland Delineations (with appropriate line type, i.e. PSS, RUS, etc.)
19) Existing Property Lines
20) Utilities

Dimension:

1) Project Transition Lengths
2) Bridge Skew
3) Span Length(s)

Label:

1) Detail Name (PLAN)
2) Scale (Bar scale)
3) North
4) Name of Road/Route
5) Name of Body of Water
6) Flow Direction
7) CL Bearing Substructures (label station)
8) CL Buried Structure (include structure type and station)
9) Railroads, Houses, Drives and other significant existing features (usually picked up and labeled with the survey)
10) Alignment Stationing
11) PC, PT, & PI (Leader-line and Point Symbol, with Station)
12) Curve Data

13) Direction of tangent sections of centerline construction
14) Direction to Nearest Town or Major Road (point w/ arrow)
15) Temporary Detour (if shown)
16) Fore Slope & Back Slope, i.e. "1:3" (w/slope arrows)

   ♬ Label slopes every 100' and at transition points, i.e. the last and first location of each separate slope.

17) Riprap Slope
18) Clearing Limits
19) Begin Transition, Begin Project, End Project, End Transition (w/ Sta. For each)
20) Limit of work (if limit is beyond transition)
21) Utilities
22) Proposed Drainage Structures
23) Sill & Well Cover Elevations
24) Match Marks (for plans that span sheets)
25) Guardrail Termination (i.e. MELT)
26) Riprap Downspouts
27) Parking
28) Rehabilitation items (guardrail, end posts, joints, etc.)
29) Riprap Pads
30) Plan/Heavy Riprap
31) Stone Ditch Protection

2.4.7.2 Profile

Intro: The profile is cut along the CL Construction and is used to show the vertical alignment, existing and proposed structure and existing grade.

Sheet-up: The profile will be shown either on sheet two of the preliminary plans or on sheet one along with the plan, depending on room.

Scale: Horizontal scale, 1"=25', Vertical Scale 1"=5'

Draw/Show:

1) CL Structure (Buried Structure)
2) CL Brgs Substructure
3) Grid (1"=25' Horiz./ 1"=5' Vert.)
4) Proposed grade at CL Construction
5) Proposed Subgrade

6) Existing Grade at CL Construction
7) Approximate Ledge
8) Approximate Streambed
9) Existing Structure (Super and Sub)
10) Proposed Structure (Superstructure, Substructures, Piles, Approach Slabs, etc.)
11) Backfill/Structural Earth Excavation Limits
12) Riprap (in front of abutments)

Dimension:

1) Length of vertical curves
2) Project transition lengths
3) Span Length
4) Limits of Excavation and Borrow

Label:

1) Detail Name ("PROFILE")
2) CL Brgs. Substructure (with Stations)
3) CL Buried Structure (with Station and structure type)
4) Grid lines
5) Begin Transition, Begin Project, End Project, End Transition (w/ Sta. For each)
6) Scale (Bar scale showing both horizontal and vertical scales)
7) Grades in % on tangent sections and vertical curves
8) Finished grade elevations @ grid stations
9) Stations and Elevations of PVCs, PVIs, PVTs (w/ Point Symbol and Tangent extensions)
10) Proposed Grade at CL Construction
11) Proposed Subgrade
12) Proposed Superstructure
13) Proposed Substructures
14) Proposed Piles (generic callout, not explicit pile size.)
15) Approach Slab
16) Existing Grade at CL Construction
17) Approximate Ledge
18) Approximate Streambed
19) Existing Structure to be Removed
20) Existing Structure to Remain

21) Backfill/Structural Earth Excavation Limits
22) Riprap & Slope
23) Riprap Shelf Elevations
24) Q1.1 and/or Q50 water line (w/elevation & symbol)

2.4.7.3 Existing Bridge Section

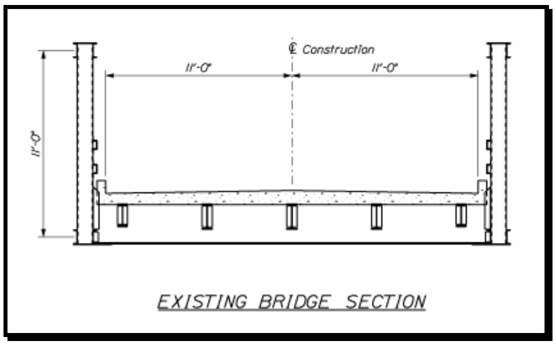

Figure 2-11 Existing Bridge Section

Intro: The preliminary plans typically show a transverse section of the existing structure. This applies only to traditional bridges and not buried structures.

Sheet-up: This section goes wherever it will fit, either on the plan, profile, or on a typical sections sheet.

Scale: ¼”

Draw:

1) CL Construction
2) Superstructure, including deck, steel &/or precast
3) Wearing surface
4) Rail system
5) Utilities

Dimension:

1) Deck Width
2) Road width (tie to CL Construction)
3) Curb width
4) Beam spacing & overhang (tied to CL Construction)

Label:

1) Detail Name “EXISTING BRIDGE SECTION”
2) CL Construction
3) Pavement Thickness (Wearing surface projects)

4) Utilities

2.4.7.4 Proposed Bridge Section (Traditional Bridge)

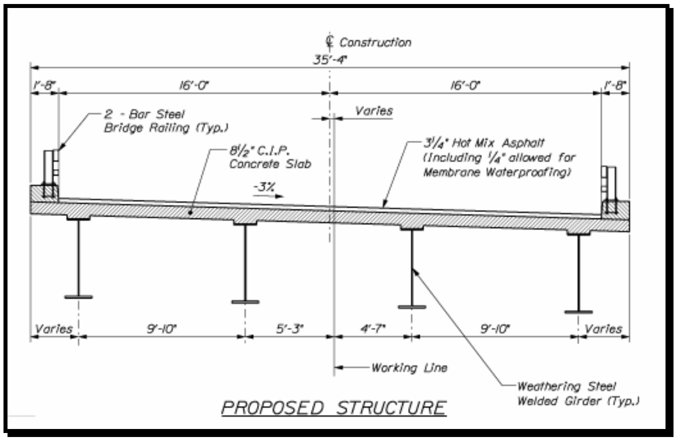

Figure 2-12 Proposed Bridge Section (Traditional Bridge)

Intro: The preliminary plans require a transverse section of the proposed superstructure.

Sheet-up: Belongs on the first sheet where it will fit, either the Plan, Profile or, if required, on an additional Typical Sections Sheet.

Scale: ¼"

Draw:

1) CL Construction
2) Working Line
3) Superstructure, including deck, steel &/or precast
4) Wearing Surface
5) Curbs/Sidewalks
6) Superstructure Rail System
7) Lighting
8) Bridge Drains
9) Utilities

Dimension:

1) Deck width
2) Road width (tie to CL Construction)
3) Curb width
4) Beam spacing & overhang
5) Relationship between working line and CL Construction

Label:

1) Detail Name "PROPOSED BRIDGE SECTION"
2) Deck Thickness and type
3) Cross-slope of finished grade
4) CL Construction
5) Working Line
6) Bridge drains
7) Attached utilities
8) Wearing Surface type and thickness (w/membrane waterproofing)
9) Bridge rail type
10) Girder type (beam or precast)

2.4.7.5 Proposed Bridge Section (Buried Structures)

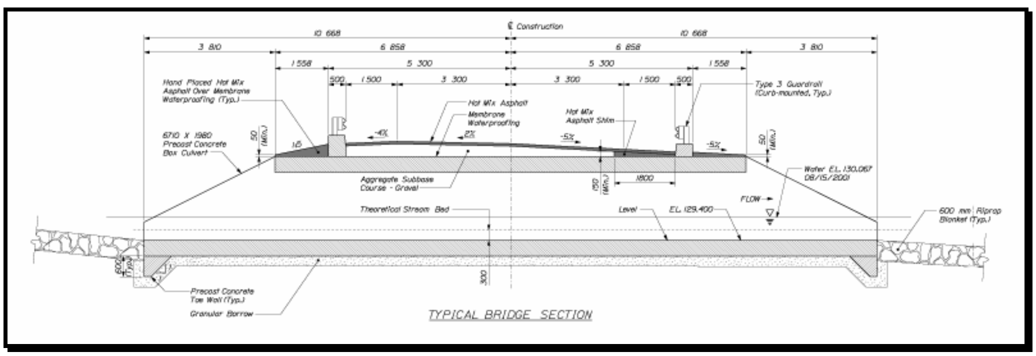

Figure 2-13 Proposed Bridge Section (Buried Structures)

Intro: The preliminary plans require a section through buried structures. This section is cut through the structure along the CL of structure, and therefore not always perpendicular to CL Construction.

Sheet-up: Belongs on either the plan, profile or typical sections sheet.

♫ Typically, the section of the buried structure is too big to fit on either the plan or profile, and requires a Typical Sections sheet.

Scale: ¼"

Draw:

1) CL Construction
2) Structure
3) Plain Riprap
4) Riprap Blanket
5) Pavement

6) Subbase
7) Rail System
8) Existing Grade
9) Proposed Grade
10) Theoretical Streambed
11) Granular Borrow Limits
12) Toe Walls

Dimension:

1) Structure Length
2) Structure End to CL Construction/Working Line
3) End Bevel/Step (both horizontal and vertical)
4) Roadway widths (only if structure is normal to CL Construction)
5) Riprap Blanket
6) Depth Below theoretical Streambed
7) Thickness of Granular Borrow Bedding Material
8) Toe Wall Depth

Label:

1) Detail Name "TYPICAL BRIDGE SECTION"
2) CL Construction / Working Line
3) Structure Type & Size
4) Toe Walls
5) End Bevel Slope
6) Inlet & Outlet Invert Elevations
7) Flow
8) Theoretical streambed
9) Existing streambed
10) Plain Riprap
11) Riprap blanket thickness
12) Existing Ground
13) Granular Borrow Bedding Material
14) Stabilization Geotextiles
15) Section/Detail Cuts (cross-section of structure is sometimes required to show slip-linings, invert linings, etc.)

2.4.7.6 Approach Design Section

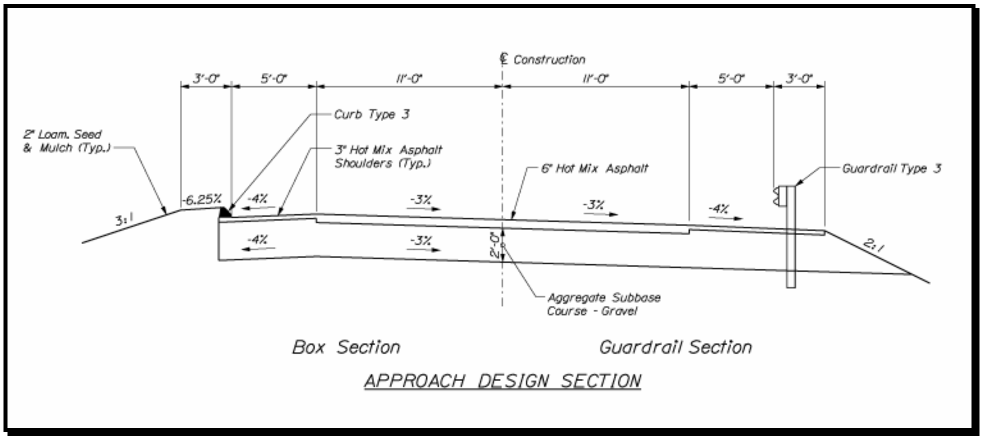

Figure 2-14 Approach Design Section

Intro: This section shows the proposed roadway design. All roadway parameters must be established, which sometimes requires more than one design section (i.e. guardrail vs. non-guardrail, box-section vs. ditched section, sidewalks, curbs, etc.)

Sheet-up: This section can be shown on any of the preliminary sheets where it will fit. Try to keep it together with the other proposed sections, i.e. the bridge sections.

Scale: 1”=5’-0”

Draw:

1) CL Construction
2) Pavement
3) Subgrade
4) Finished Grade
5) Curbs / Sidewalks
6) Rail System
7) Fore Slopes / Back Slopes
8) Ditch

Dimension:

1) Width of travel ways, shoulders, curbs, sidewalks, etc. (tied to CL Construction)
2) Thickness of subbase
3) Typical distance from bottom of ditch to bottom of subbase (usually one foot)
4) Embedment of Guardrail Post (reduced berm offset only)

Label:

1) Detail Name “APPROACH DESIGN SECTION”
2) Design Section Type (i.e. Guardrail, Non-Guardrail, Box-Section, etc.)

3) CL Construction
4) Guard rail type
5) Fore slope and back slope (i.e. "1:3")
6) Cross-slope % of travelway, subbase, sidewalk, shoulder, etc.
7) Point to sideslopes and call out loam thickness and erosion control type, i.e. seed and mulch
8) Pavement thickness and type at travelway and shoulders
9) Curb type
10) Ditch protection (Erosion control blanket or riprap)

2.5 Final Approach Plans

2.5.1 Introduction

Approaches are finalized after formal public participation and before structural detailing is commenced. At this stage the detailer will complete a general plan and profile and develop cross sections and any other geometry sheets required.

2.5.2 Prerequisites

2.5.2.1 To Get Started

Begin with approved Preliminary Plans.

↳ Refer to section 2.4.2 for items required to complete Preliminary Plan.

2.5.2.2 To Finish Up

You will need to revise your preliminary plans to reflect any refinements to the design, as well as to add information that may not have been a part of preliminary design.

1) Proposed Utilities
2) Guardrail limits
3) Wall lengths and locations
4) Substructure size and location
5) Superstructure size, type, and location
6) Riprap limits
7) Drainage

2.5.3 Detailing

2.5.3.1 Workflow

The following workflow is provided to offer a brief perspective on one approach to detailing a final approach plan set.

1) Address Public Concerns
2) Make changes to Drainage Design (Catch Basin Locations, Underdrain, etc.)
3) Finalize Utilities on plan and cross-sections
4) Finalize structure on plan and profile
5) Show final wings/walls/abutments (if needed) on cross-sections
6) Finalize roadway on plan, profile and cross-sections
7) “Plan Impacts Complete” Milestone (Approach Plans approved by Team)

8) Final Property Mapping
9) Develop Right Of Way Control Points Sheet

2.5.4 Typical Sheet Names and Contents

2.5.4.1 General Plan

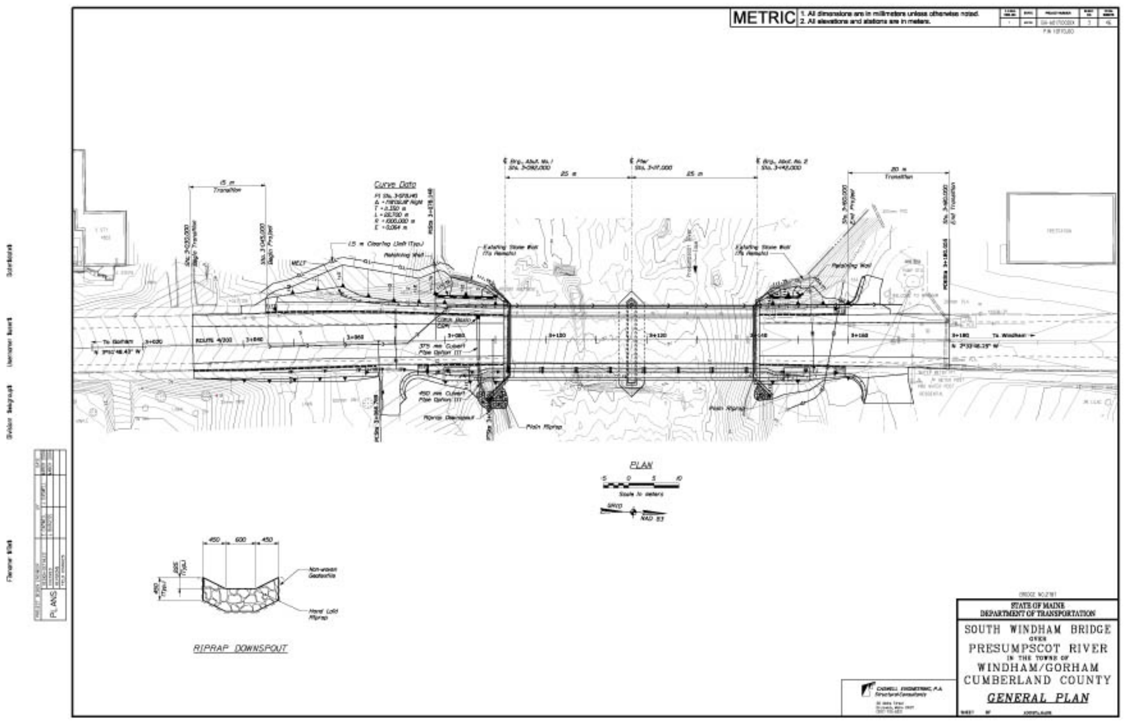

Figure 2-15 General Plan Sheet

Will Contain:

1) Plan

May Contain:

Additional details

2.5.4.2 Curb Geometry

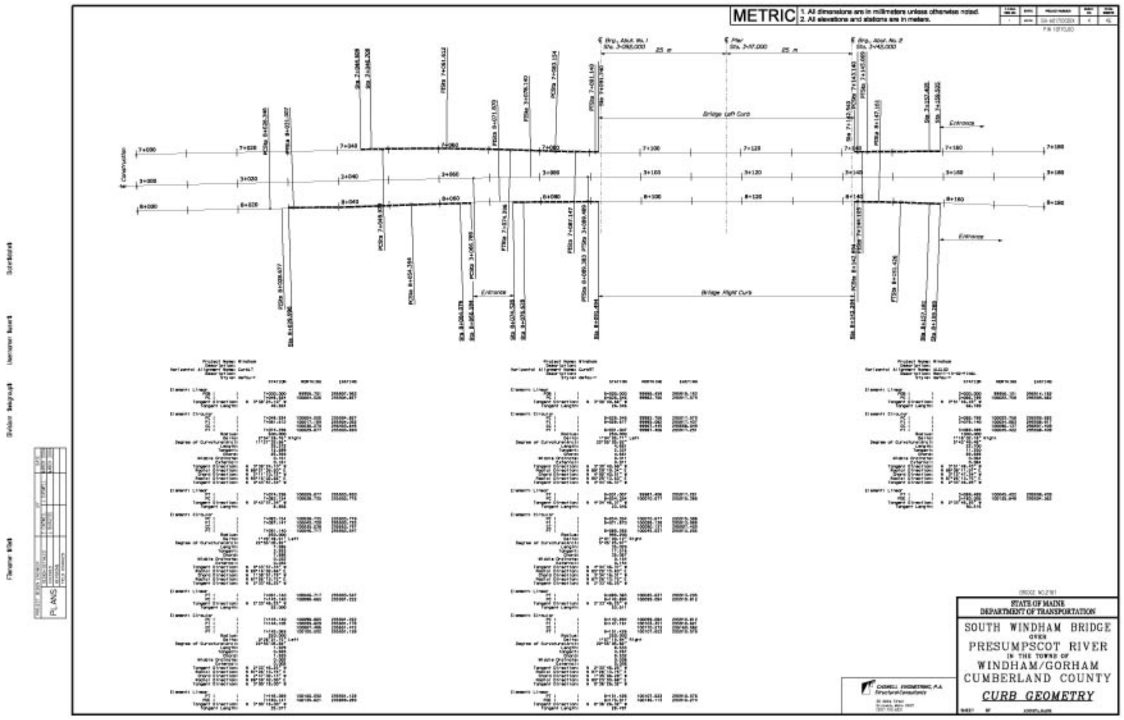

Figure 2-16 Curb Geometry Sheet

Will Contain:

1) Curb Geometry Plan
2) Curb Geometry Alignment Data

2.5.4.3 Profile

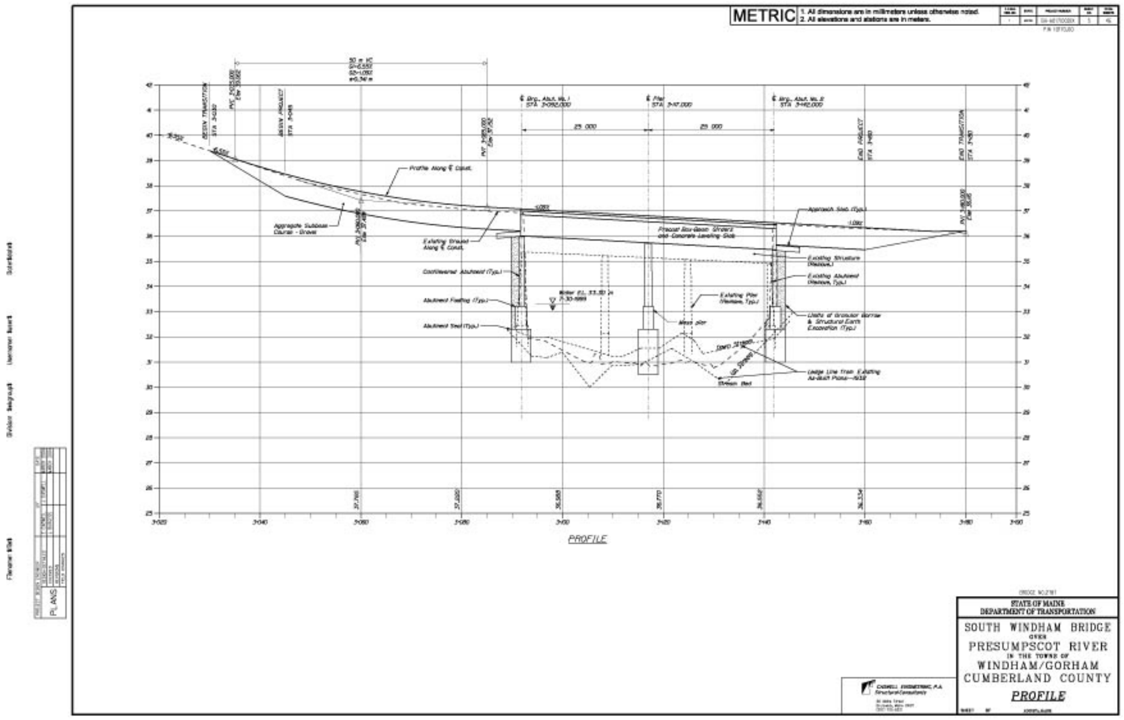

Figure 2-17 Profile Sheet

Will Contain:

1) Profile

2.5.4.4 Guardrail Layout

Will Contain:

1) Guardrail Layout Plan
2) Item List with quantities.

2.5.4.5 Intersection Geometry

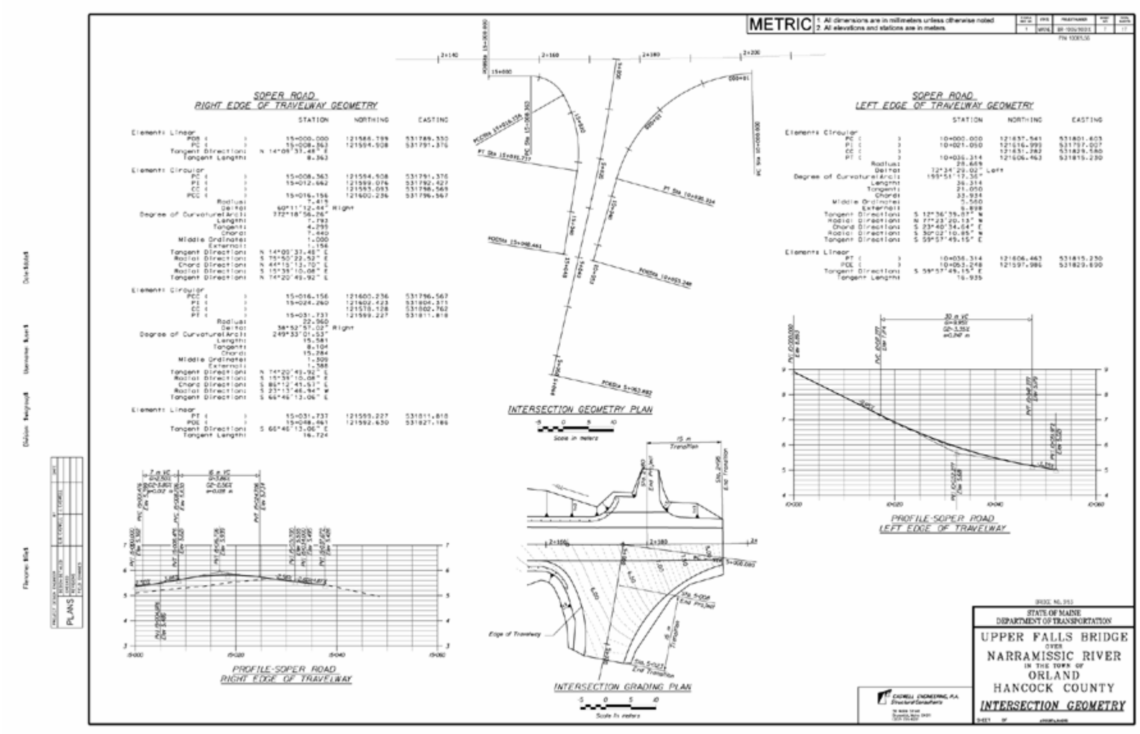

Figure 2-18 Intersection Layout Sheet

Will Contain:

1) Intersection Geometry Plan
2) Intersection Grading Plan

May Contain:

1) Station/Offset table of points
2) Curve Data
3) Profiles and Alignment Data for Edge of Travelway

2.5.4.6 Cross Section

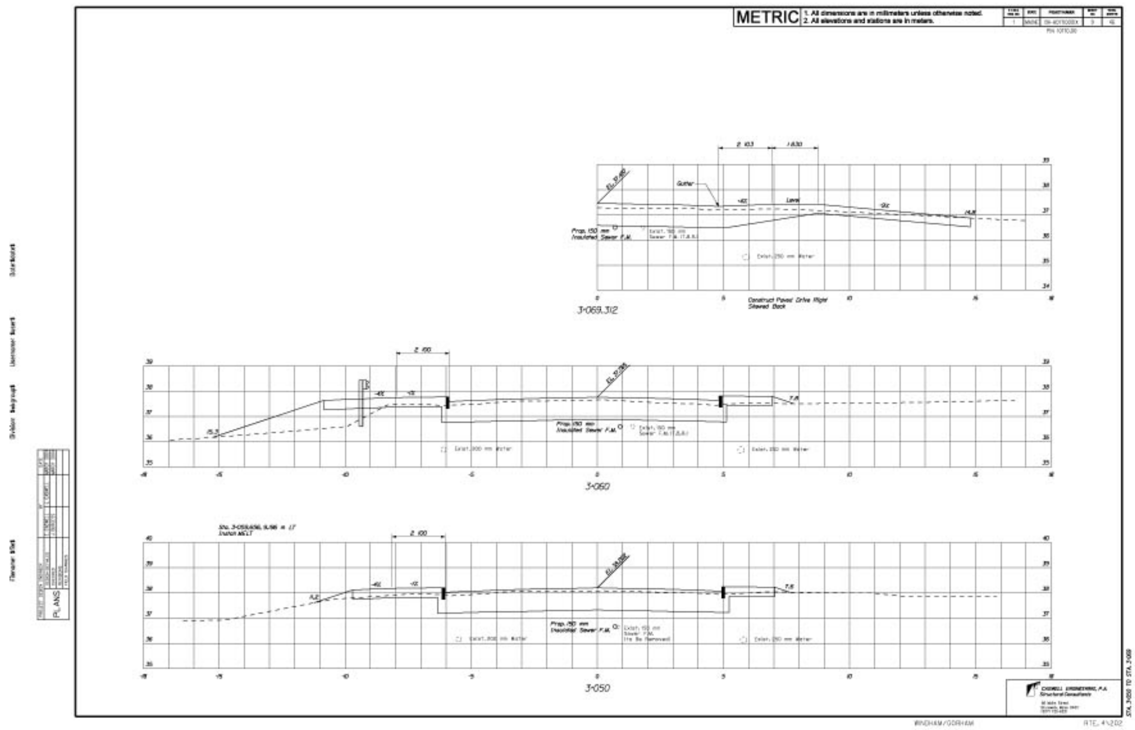

Figure 2-19 Cross Section Sheet

Will Contain:

1) Approach Design Section
2) Cross-sections

2.5.5 Checklists

2.5.5.1 Plan

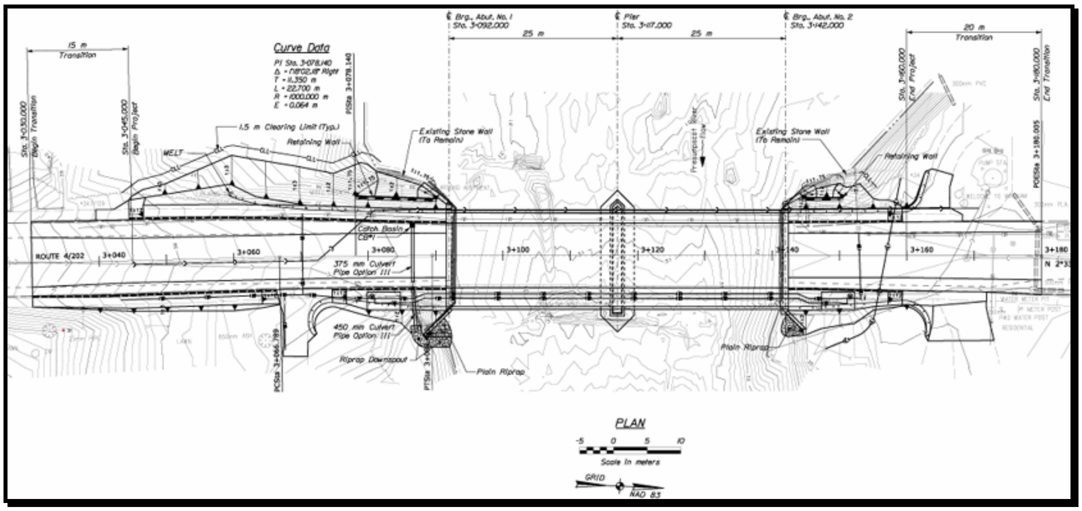

Figure 2-20 Plan

Intro: Top view of the project, intended to show roadway impacts and structure.

Sheet-up: The plan view is shown typically on the "GENERAL PLAN" sheet.

Scale: 1"=25'

Draw/Show:

1) Centerline Construction
2) CL Brg. Substructure
3) Limits of Superstructure and Substructure
4) Curb/Sidewalk and Rail on Superstructure
5) All proposed features (plain riprap, gabions, downspout, etc…)
6) Edge of Travelway
7) Guardrail
8) Berm
9) Toes of slope
10) Ditches with flow lines
11) Clearing Limits
12) Drives, paved aprons
13) End of Project limits
14) Temporary Detour w/ alignment, roadway limits and toes of slope (if req'd)
15) Contours

16) Topo / Survey
17) Wetland Delineations (with appropriate line type, i.e. PSS, RUS, etc.)
18) Existing Property Lines
19) Utilities

Dimension:

1) Project Transition Lengths
2) Bridge Skew
3) Span Length(s)

Label:

1) Detail Name (PLAN)
2) Scale (Bar scale)
3) North
4) Name of Road/Route
5) Name of Body of Water
6) Flow Direction
7) CL Bearing Substructures (label station)
8) CL Buried Structure (include structure type and station)
9) Railroads, Houses, Drives and other significant existing features (usually picked up and labeled with the survey)
10) Alignment Stationing
11) PC, PT, & PI (Leader-line and Point Symbol, with Station)
12) Curve Data
13) Direction of tangent sections of centerline construction
14) Direction to Nearest Town or Major Road (point w/ arrow)
15) Temporary Detour (if shown)
16) Fore Slope & Back Slope, i.e. "1:3" (w/slope arrows)

    - Label slopes every 100' and at transition points, i.e. the last and first location of each separate slope.

17) Riprap Slope
18) Clearing Limits
19) Begin Transition, Begin Project, End Project, End Transition (w/ Sta. For each)
20) Limit of work (if limit is beyond transition)
21) Utilities

22) Proposed Drainage Structures
23) Sill & Well Cover Elevations
24) Match Marks (for plans that span sheets)
25) Guardrail Termination (i.e. MELT)
26) Riprap Downspouts
27) Parking
28) Rehabilitation items (guardrail, end posts, joints, etc.)
29) Riprap Pads
30) Plain/Heavy Riprap
31) Stone Ditch Protection

2.5.5.2 Profile

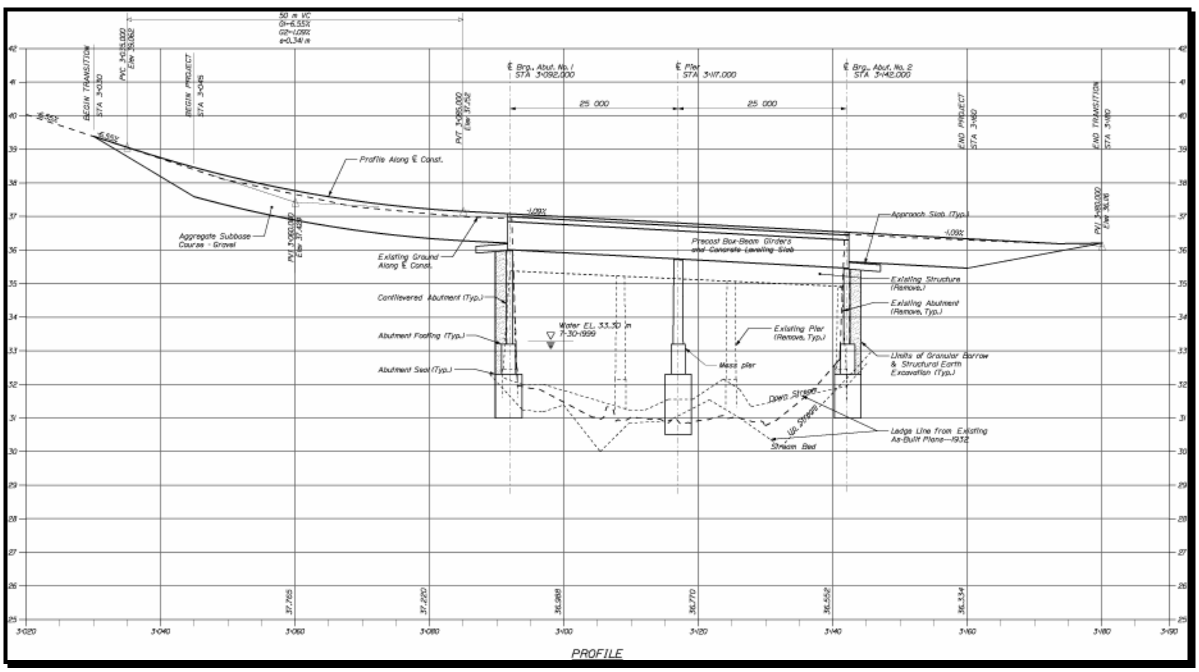

Figure 2-21 Profile

Intro: The profile is cut along the CL Construction and is used to show the vertical alignment, existing and proposed structures and existing grade.

Sheet-up: The profile will be shown either on a combination plan/profile sheet, or, more commonly, on its own sheet titled “PROFILE.”

Scale: Horizontal scale, 1”=25’, Vertical Scale 1”=5’

Draw/Show:

1) CL Structure (Buried Structure)

2) CL Brgs Substructure
3) Grid (1”=25’ Horiz./ 1”=5’ Vert.)
4) Proposed grade at CL Construction
5) Proposed Subgrade
6) Existing Grade at CL Construction
7) Approximate Ledge
8) Approximate Streambed
9) Existing Structure (Super and Sub)
10) Proposed Structure (Superstructure, Substructures, Piles, Approach Slabs, etc.)
11) Backfill/Structural Earth Excavation Limits
12) Riprap (in front of abutments)

Dimension:

1) Length of vertical curves
2) Project transition lengths
3) Span Length
4) Limits of Excavation and Borrow

Label:

1) Detail Name (“PROFILE”)
2) CL Brgs. Substructure (with Stations)
3) CL Buried Structure (with Station and structure type)
4) Grid lines
5) Begin Transition, Begin Project, End Project, End Transition (w/ Sta. For each)
6) Scale (Bar scale showing both horizontal and vertical scales)
7) Grades in % on tangent sections and vertical curves
8) Finished grade elevations @ grid stations
9) Stations and Elevations of PVCs, PVIs, PVTs (w/ Point Symbol and Tangent extensions)
10) Proposed Grade at CL Construction
11) Proposed Subgrade
12) Proposed Superstructure
13) Proposed Substructures
14) Proposed Piles (generic callout, not explicit pile size.)
15) Approach Slab
16) Existing Grade at CL Construction

17) Approximate Ledge
18) Approximate Streambed
19) Existing Structure to be Removed
20) Existing Structure to Remain
21) Backfill/Structural Earth Excavation Limits
22) Riprap & Slope
23) Riprap Shelf Elevations

2.5.5.3 Intersection Geometry Plan

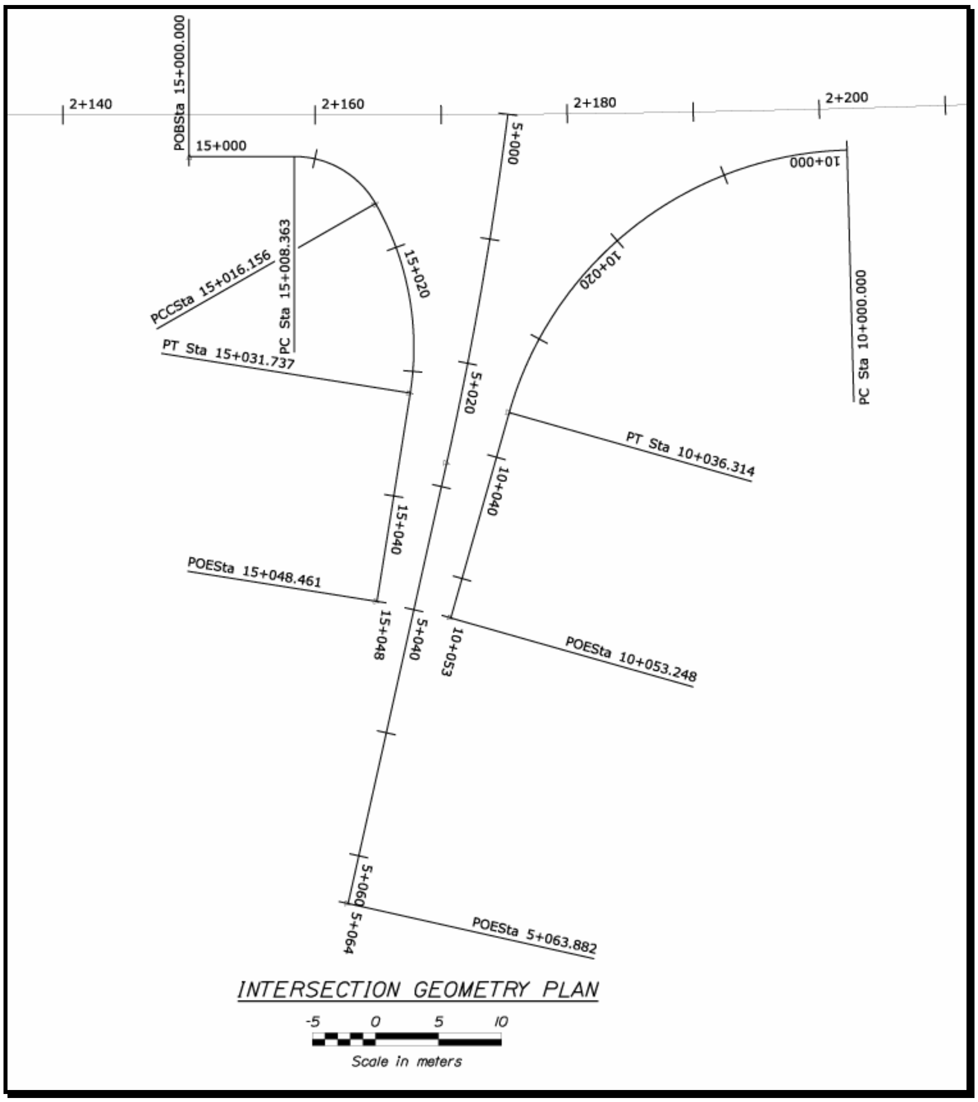

Figure 2-22 Intersection Geometry Plan

Intro: an intersection layout plan is required where roadway construction requirements at an intersection can't be communicated clearly by standard means (plan, typical sections, cross-sections.)

Sheet up: belongs on an Intersection Geometry sheet

Scale: Depends on the length of roadway to detail, try 1"=10'

Draw/Show:

1) CL Construction Main Line
2) CL Construction Intersecting Road
3) Edge of Traveled Way
4) Berm
5) CL Bearing Substructures (as required)
6) Limits of superstructure/substructures (as required)

Dimension:

1) Radius of curved roadway lines (ETW, Berm, etc.)
2) Angle between CLs of Main Line and Intersecting Roadway

Label:

1) Detail Name ("INTERSECTION GEOMETRY PLAN")
2) Detail Scale (w/ Bar Scale)
3) North
4) CL Brgs. Substructures
5) Mainline and Side Route Stationing
6) ETW, Berm, Turning Lanes, etc.
7) Critical Points (low points, breakpoints)
8) Curve Data, including PC, PT, and PI Points
9) Alignments Bearings

2.5.5.4 Intersection Grading Plan

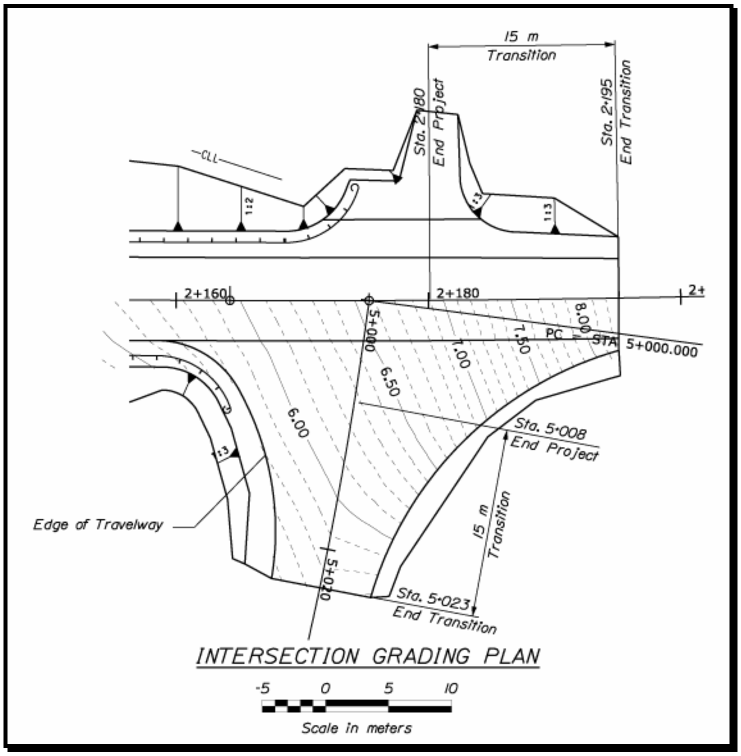

Figure 2-23 Intersection Grading Plan

Intro: may be used to provide contours of an intersection to demonstrate drainage. An exaggerated contour interval may be necessary to convey the intersection grading intent.

Sheet up: belongs on Intersection Geometry Sheet

Scale: 1"=25'

Draw/Show:

1) CL Construction
2) CL Side Road
3) ETW, Berm, face of guardrail, toes of slope, slope arrows
4) Contours
5) Underdrain
6) Toes of Slope
7) Guardrail

Dimension:

1) Transition Lengths

Label:

1) Detail Name ("INTERSECTION GRADING PLAN")

2) Scale (w/ Bar Scale)
3) North
4) Stationing
5) Contours
6) Intersection Station

2.5.5.5 Curb Geometry

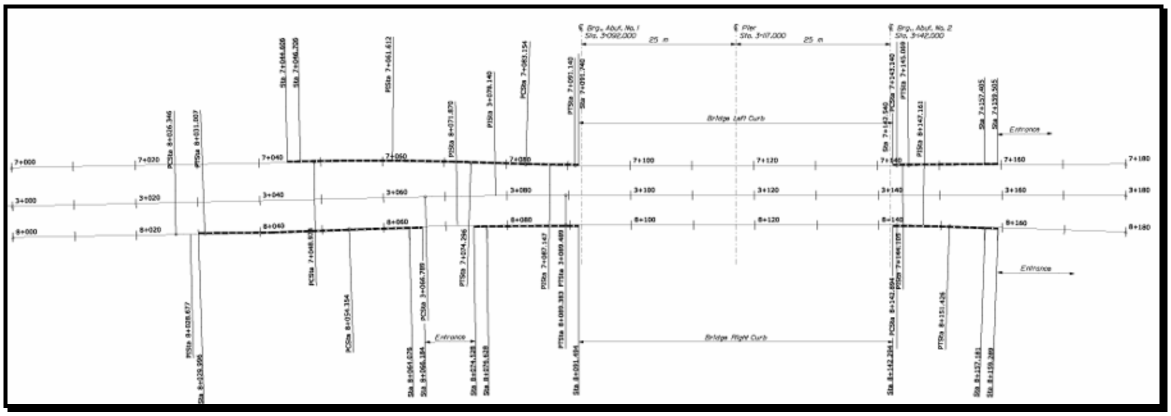

Figure 2-24 Curb Geometry

Intro: curb geometry is provided for projects where curb location is not adequately defined by the transverse section, plan, and cross-sections. A typical example would be on an urban project where curbs/sidewalks are not parallel to the CL Construction.

Sheet up: belongs on a Curb Geometry Sheet

Scale: depends on the length of curb to be detailed, may be as small as 1"=25.

Draw/Show:

1) CL Construction
2) CL Substructures (as req'd)
3) Alignment of each curb
4) Curb limits

Dimension:

1) Span Lengths

Label:

1) Detail Name ("CURB GEOMETRY PLAN")
2) North
3) CL Construction
4) CL Brg. Substructures
5) Stationing for CL Construction

6) Stationing for each Curb Alignment
7) Entrances through curb
8) Bridge Curb
9) Begin and end stations for each curb pay item
10) Complete alignment info for each alignment
11) PC, PT, PI for each Curb Alignment

2.5.5.6 Guardrail Layout Plan

Intro: guardrail layout sheets are required when the geometry of the guardrail is atypical and complicated. It is used to provide precise information about the location and amount of each type of guardrail (curved, straight, bridge transition, MELT, etc.)

Sheet up: plans and item lists belong on the Guardrail Layout sheet.

Scale: Scale will vary depending on how long a section of guardrail you need to detail. A full project might need to be broken up and shown at 1"=10'.

Draw:

1) CL Construction / Working Line
2) Face of Guardrail
3) Guardrail Terminal ends and MELTS, etc
4) CL of Bearing Substructures as required.

Dimension:

1) Radius of curved guardrail panels

Label:

1) Centerline Stationing
2) CL Brgs. Substructure
3) Point to Guardrail and call out by Item Number. Include the following information:
   a) Begin Station
   b) End Station
   c) Length
4) Face of Rail
5) Provide notes that list estimated amounts of all guardrail Pay Items, include:
   a) Item No.
   b) Item Description
   c) Station from, station to, side (LT or RT) and length

2.5.5.7 Approach Design Section

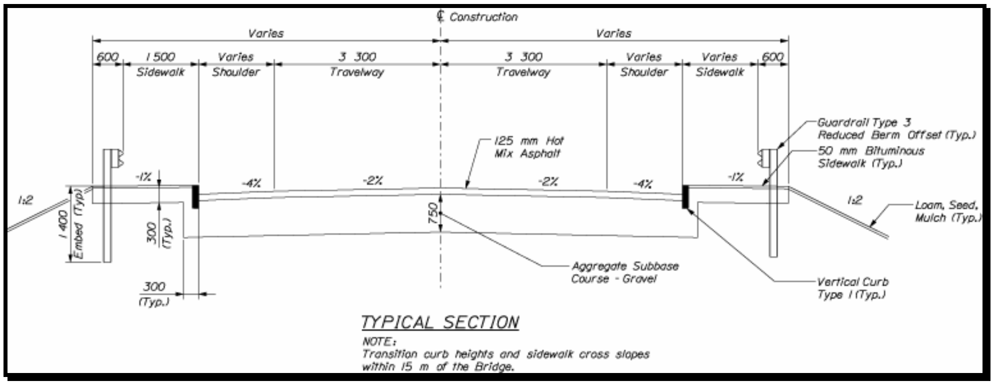

Figure 2-25 Approach Design Section

Intro: This section shows the proposed roadway design. All roadway parameters must be established, which sometimes requires more than one design section (i.e. guardrail vs. non-guardrail, box-section vs. ditched section, sidewalks, curbs, etc.)

Sheet-up: This section is shown with the cross-sections. It belongs at the bottom of the page, before the first section. Align the centerlines.

Scale: 1"=5'-0"

Draw:

1) CL Construction
2) Pavement
3) Subgrade
4) Finished Grade
5) Curbs / Sidewalks
6) Subsurface Drainage
7) Utilities
8) Rail System
9) Fore Slopes / Back Slopes
10) Ditch

Dimension:

1) Width of travel ways, shoulders, curbs, sidewalks, etc. (tied to CL Constrctruction)
2) Thickness of subbase
3) Typical distance from bottom of ditch to bottom of subbase (usually one foot)
4) Embedment of Guardrail Post (reduced berm offset only)

Label:

1) Detail Name "APPROACH DESIGN SECTION"

2) Design Section Type (i.e. Guardrail, Non-Guardrail, Box-Section, etc.)
3) CL Construction
4) Guard rail type
5) Fore slope and back slope (i.e. “1:3”)
6) Cross-slope % of travelway, subbase, sidewalk, shoulder, etc.
7) Point to sideslopes and call out loam thickness and erosion control type, i.e. seed and mulch
8) Pavement thickness and type at travelway and shoulders
9) Curb type
10) Ditch protection (Erosion control blanket or riprap)

2.5.5.8 Cross-Sections

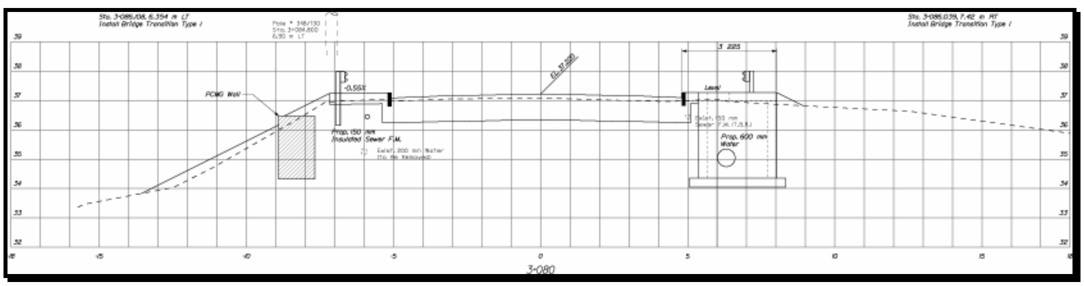

Figure 2-26 Cross Section

Intro: Cross-sections are transverse sections of the roadway cut at regular and critical stations along the project. They primarily communicate earthwork and utility requirements.

Sheet-up: Cross-Sections are stacked 2 or 3 per sheet, increasing station bottom to top of page, increasing station also in successive sheets.

- Each Cross-Section border should label the town, route, and cross-section stations shown on the page. This information belongs in the lower right hand corner, outside the solid-line border.

Scale: 1”=5’

Draw:

1) Gridlines
2) Existing ground
3) Ledge Outcrops
4) Travel way, shoulders, subbase, curbs, drives, side slopes, ditches etc.
5) Pavement
6) Guardrail
7) Single Trees

8) Existing and proposed poles and other utilities.
9) Houses
10) Retaining Walls
11) Catch Basins, Underdrain, Culverts, with invert elevations
12) Excavation lines for Underdrain

Label:

1) Detail Label "STATION X+XX"
2) Proposed Centerline Elevations
3) Label Side Slopes (2:1, 3:1 etc.)
4) Slope % of travelway & shoulders (with superelevation), sidewalks, drives
5) Existing poles with the station, L.T./R.T. and pole number
6) New Poles with station, offset, L.T./R.T. and Pole number
7) Existing underground utilities with as much location information as you have
8) Do not show the bridge – omit bridge sections and replace with the word "BRIDGE"
9) Install Low Volume Guardrail End / NCHRP350
10) Install Delineator Post
11) Install Terminal connector
12) Install Type Bridge Transition Type _____
13) Construct Public Recreational Access Parking Area (with location)
14) End transition Begin Project Sta.______
15) End Project Begin Transition Sta.______
16) Begin Transition – Match Existing Sta.______
17) End Transition Match Existing Sta.______
18) Proposed underground utilities with location description and elevation
19) Install _____ L.F. Type 3 Guardrail Sta._______+/- to Sta._________+/-
20) Install_____ L.F. Type 3 Guardrail at _____ Radius
21) Construct _____Ft. Wide Paved/Gravel Entrance
22) Install ______L.F. Curb Type 3 Sta._____ to Sta._____ L.T. OR R.T.
23) Install _____LF of ______ Diameter Culvert with Stations and offsets L.T./R.T.

CHAPTER 3 SUBSTRUCTURES

3.1 Table of Contents

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3.2 Abutments

3.2.1 Introduction

Abutments include the following configurations:

1) Conventional
2) Mass
3) Cantilever
4) Integral
5) Semi-integral

↪ Refer to *Bridge Design Guide* for more information.

3.2.1.1 Foundation Types

A. Integral Abutment

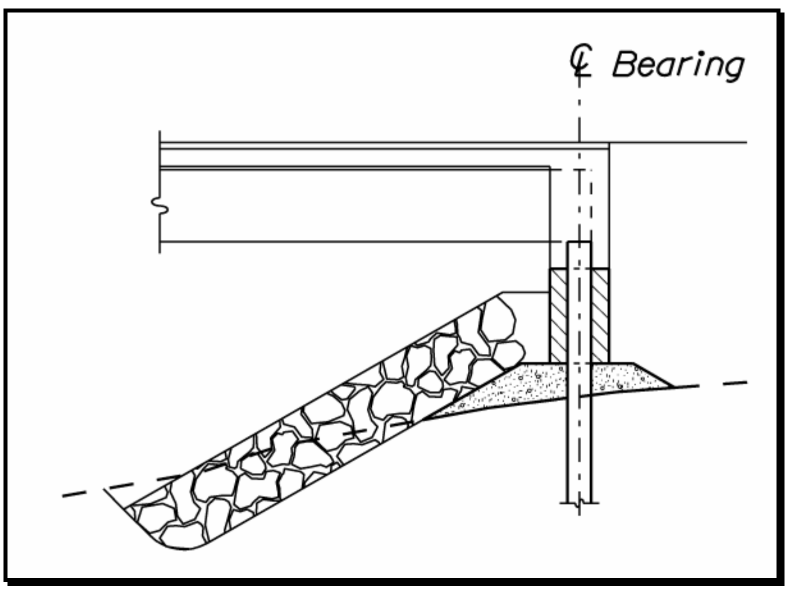


Figure 3-1 Integral Abutment

B. Footing On Ledge

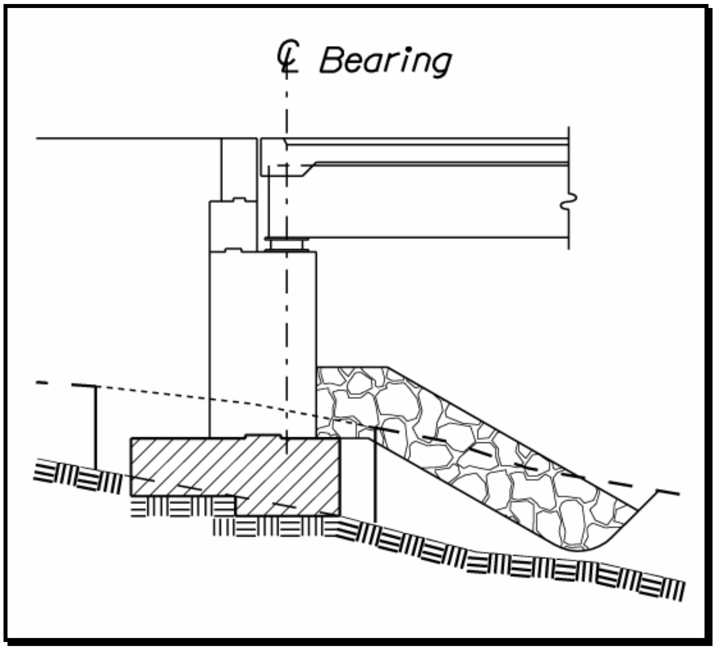


Figure 3-2 Footing On Ledge

C. Footing on Concrete Fill

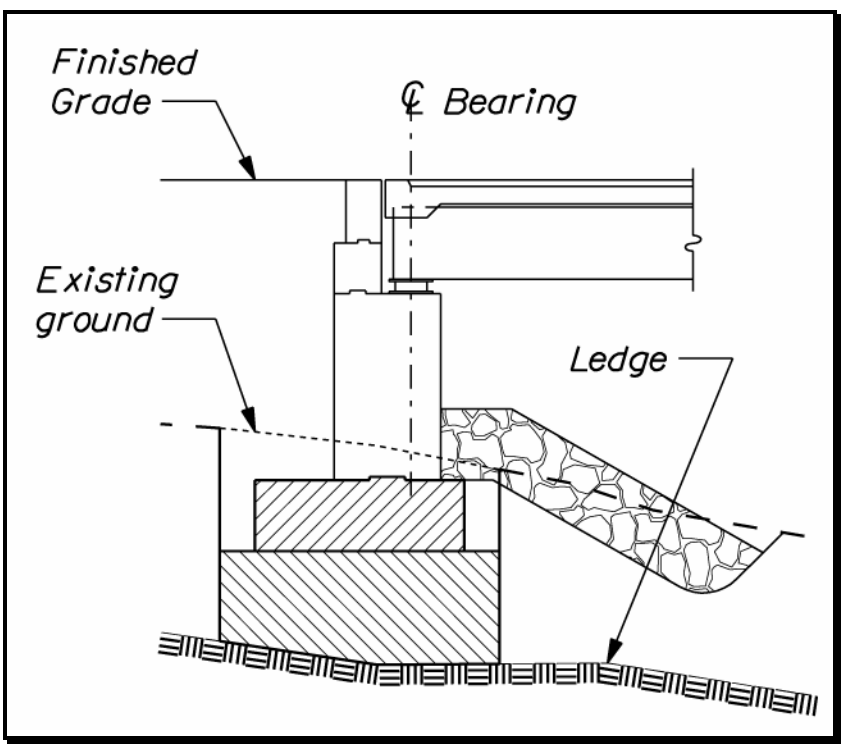


Figure 3-3 Footing On Concrete Fill

D. Footing On Piles

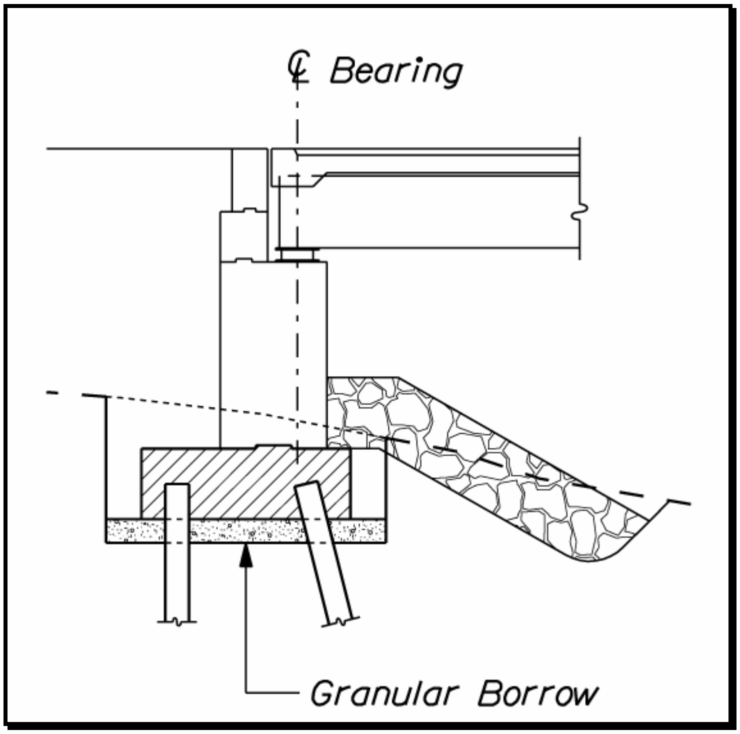


Figure 3-4 Footing On Piles

E. Spread Footing

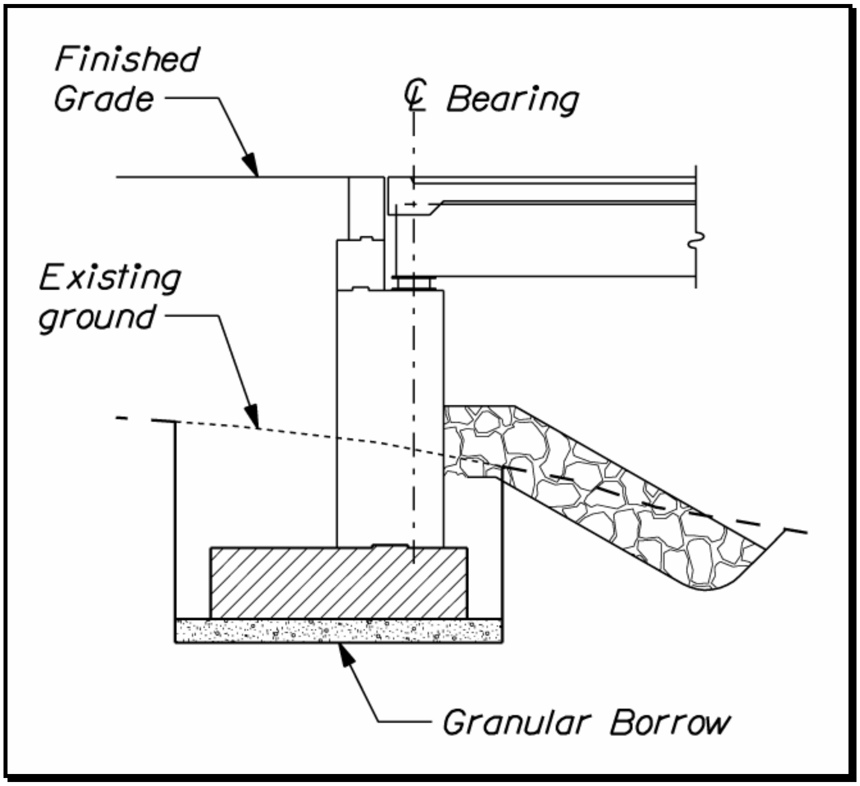


Figure 3-5 Spread Footing

3.2.2 Prerequisites

3.2.2.1 To Get Started (30% Abutment Plans)

The 30% Abutment plans show limits of concrete and pile locations. The purpose of this step is to communicate the geometric design intent to the checker. These plans show only limits of concrete and enough annotation to communicate these limits (i.e. dimensions, elevations.)

> ⓘ **It is important to not begin detailing reinforcing steel until the 30% abutment and superstructure plans have been checked by the designer/checker.**

To draw the abutments up to this level of completion, the detailer requires the following information:

1) CL Bearing Abutment Station
2) Skew Angle
3) Breastwall/Backwall Thickness
4) Footing Widths

5) Wing Lengths, Wing Angles, Wing Thickness (Lengths and angles may be calculated by the detailer. Refer to Wingwalls, section 3.2.4 for more information)
6) Top and Bottom of Footing Elevations (Sometimes Ledge or Seal Elevations)
7) Bridge Seat Elevations/Bearing heights (including preformed leveling pad thickness that is typically placed under the sole plate of the bearing)
8) Top of Backwall Elevations
9) Top of Wing Elevations
10) Top of Parapet Elevations
11) Pile Locations
12) Pile Batter
13) Joint Locations (Construction & Contraction)
14) Riprap shelf elevation
15) Backfill requirements

3.2.2.2 To Finish Up (100% Abutment Plans)

The following items are required to finish detailing an abutment:

1) Checked 30% abutment & superstructure plans
2) Completed and checked reinforcing scheme (designer will communicate reinforcing scheme to detailer via sketches)
3) Abutment and pile notes
4) Pay Limit information (structural earth excavation, integral abutment superstructure, granular borrow, membrane waterproofing, etc.)

3.2.3 Detailing

Abutment details are primarily CIP Concrete details. The Contractor is the main client to keep in mind when detailing abutments.

3.2.4 Wingwalls

3.2.4.1 General Definition

The term "wingwall" (commonly expressed simply as "wing") refers to a retaining wall that serves to contain the approach roadway fill around an abutment. The wingwall may be an integral part of the abutment or it may stand independently. Wingwalls are constructed in various geometric configurations to achieve the best balance between structure cost and the volume of embankment fill required.

3.2.4.2 Extension Wings

Extension wings project straight out from the abutment parallel to the centerline of bearing. They are the simplest type of wing to build but tend to result in the greatest volume of fill required around the abutment. They should typically be used only with relatively shallow superstructures in order to avoid excessively long wing lengths. The *Bridge Design Guide* requires that extension wings always be used with integral abutments.

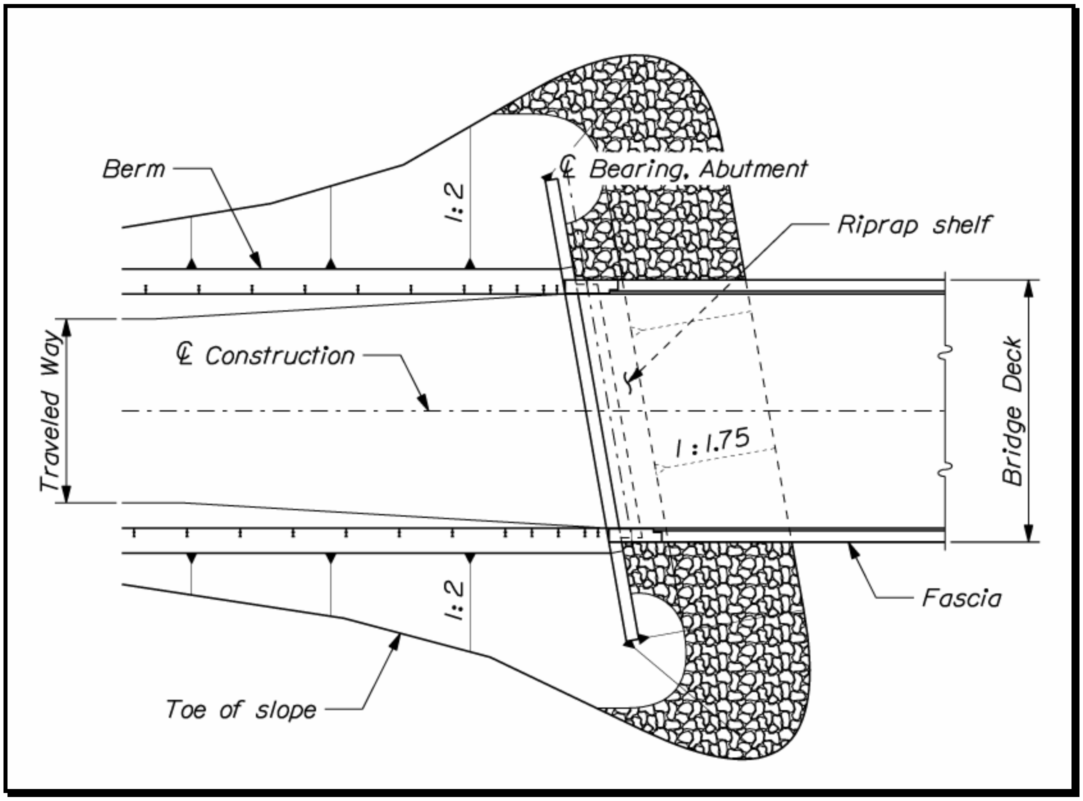


Figure 3-6 Extension Wing Plan

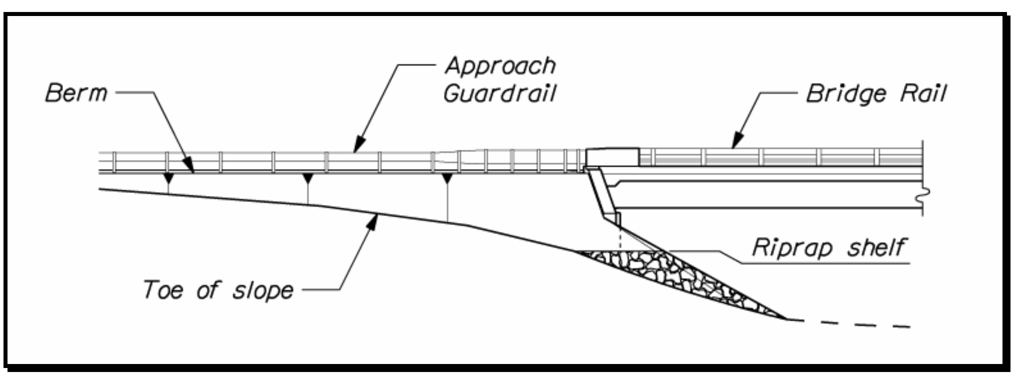
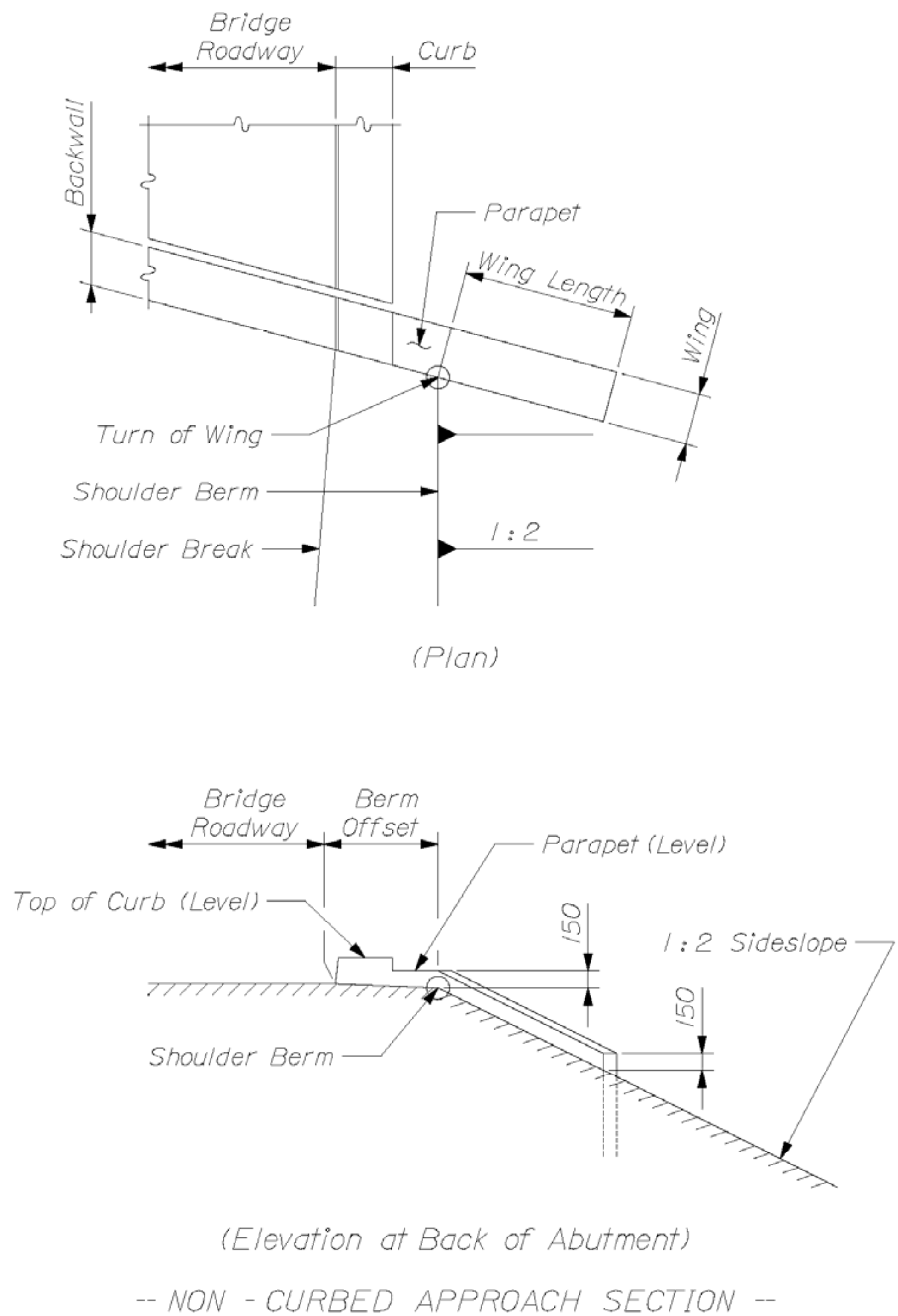


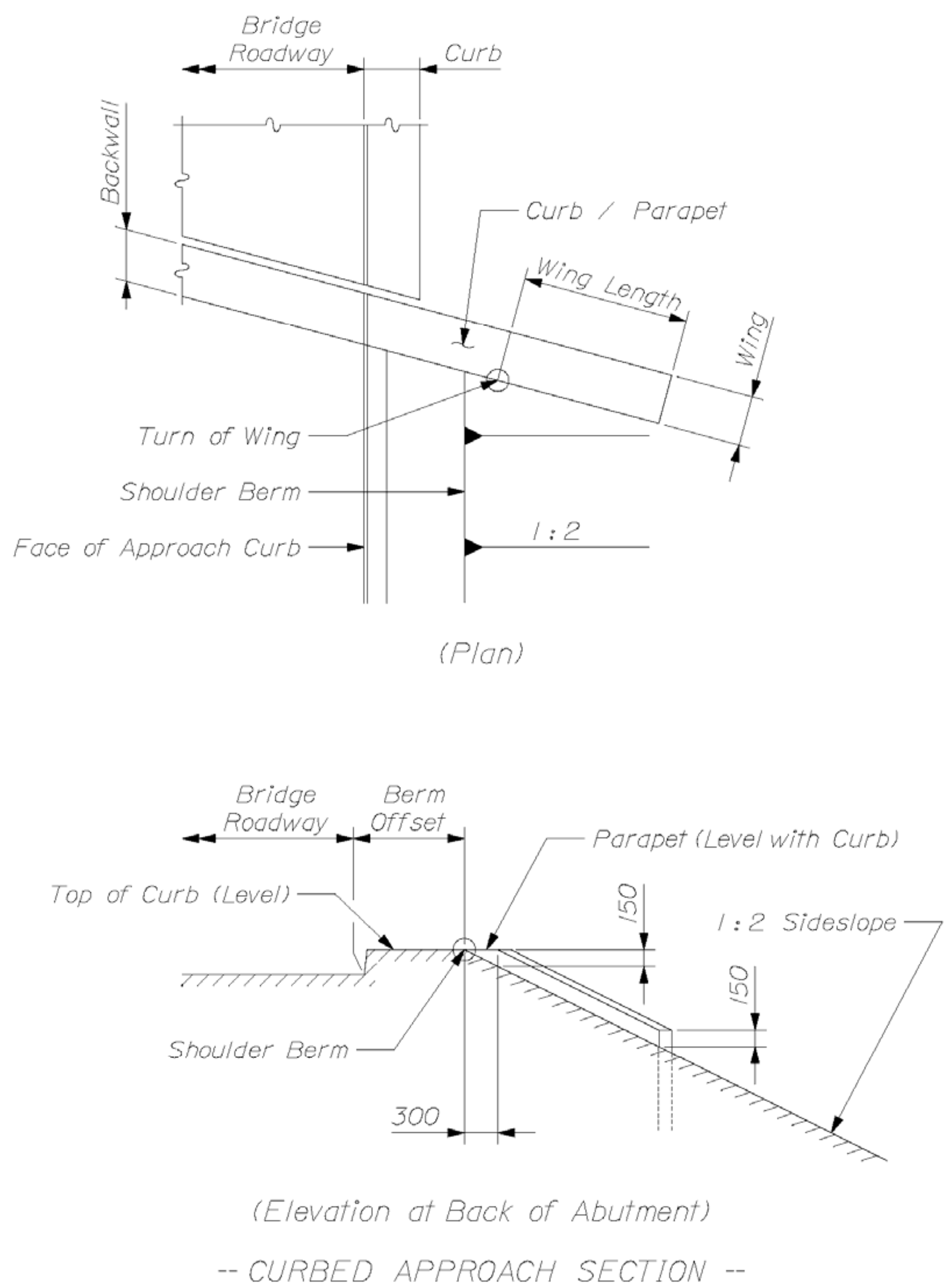
Figure 3-7 Extension Wing Elevation

A. Extension Wing on Non-Curbed Approach



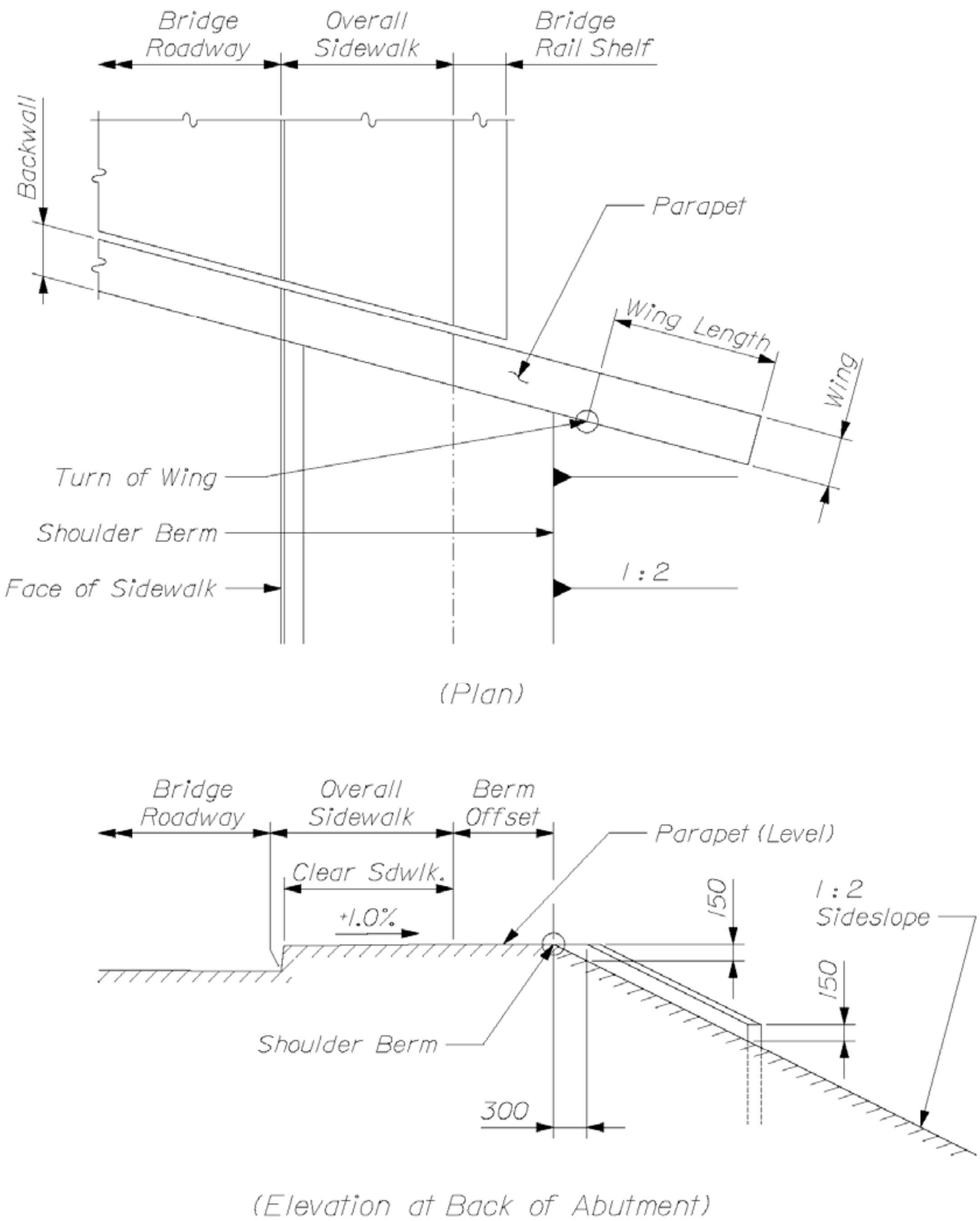
EXTENSION WING LAYOUT

B. Extension Wing on Curbed Approach



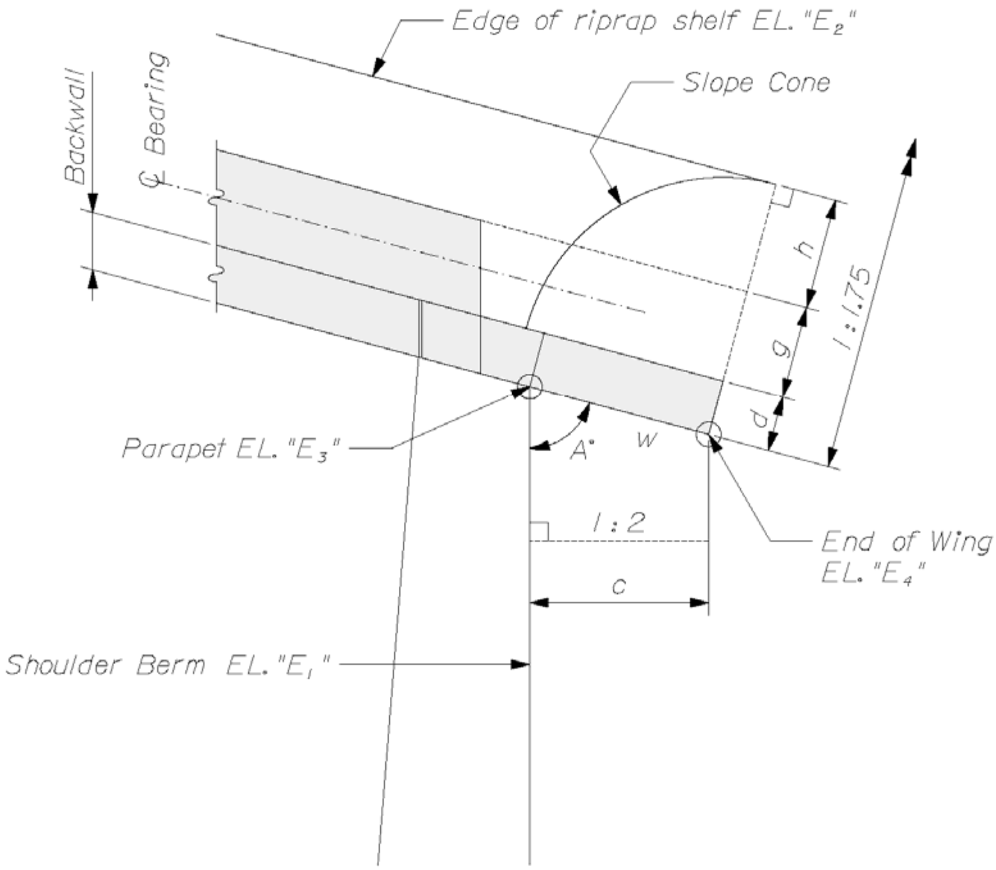
EXTENSION WING LAYOUT

C. Extension Wing on Sidewalk Approach



EXTENSION WING LAYOUT

D. Layout of Extension Wings for Stub or Integral Abutment with Riprap Shelf



-- PLAN --
(Stub or integral abutment with riprap shelf)

NOTES:

1. Angle "A" = 90° +/- Skew Angle
2. Dim. "d" = Wing thickness
3. Dim. "g" = Bridge seat width
4. Dim. "h" = Riprap shelf width
5. Dim "w" = Wing length calculated from given criteria.

EXTENSION WING LAYOUT

E. Example Calculations of Stub or Integral Abutment with Riprap Shelf

EXAMPLE CALCULATIONS
(Stub or integral abutment with riprap shelf)

Given: Skew Angle = 15°
Berm EL. "E_1" = 34.920
Riprap Shelf EL. "E_2" = 33.000
Dim. "d" = 0.450 m

Then: Wing angle A° = 90° - 15° = 75°
Change in elevation $\Delta E = E_1 - E_2 = 34.920 - 33.000 = 1.920$
$c = (\sin A)\, w$

WING LENGTH (Round to nearest 0.150 m)

$$\Delta E = \frac{(\sin A)\, w}{2} + \frac{(d + g + h)}{1.75}$$

$$1.920 = \frac{(\sin 75.0)\, w}{2} + \frac{(0.450 + 0.750 + 0.900)}{1.75}$$

$$1.920 = 0.483\, w + 1.200$$

$$0.720 = 0.483\, w$$

$$1.491 = w$$

→ Use Wing Length = 1.500 m

PARAPET ELEVATION (Round up to 0.005 m)

$$E_3 = E_1 + 0.150$$

$$= 34.920 + 0.150 = 35.070$$

→ Use Parapet EL. 35.070

EXTENSION WING LAYOUT

EXAMPLE CALCULATIONS
(Stub or integral abutment with riprap shelf)

END OF WING ELEVATION (Round up to 0.005 m)

$$E_4 = E_1 - \frac{(\sin A)\, w}{2} + 0.150$$

$$= 34.920 - \frac{(\sin 75.0)\, 1.500}{2} + 0.150$$

$$= 34.920 - 0.724 + 0.150$$

$$= 34.346$$

→ Use End of Wing EL. 34.350

EXTENSION WING LAYOUT

3.2.4.3 Return Wings

Return wings follow the line of the superstructure fascia straight back from the abutment. The bridge rail system continues along the top of the return wing, with the approach guardrail connection located at its end. Return wings generally result in the greatest concrete quantities but have the least impact to the site due to the reduced volume of fill required. Return wings are particularly suited for use with deep superstructures and high fill sections.

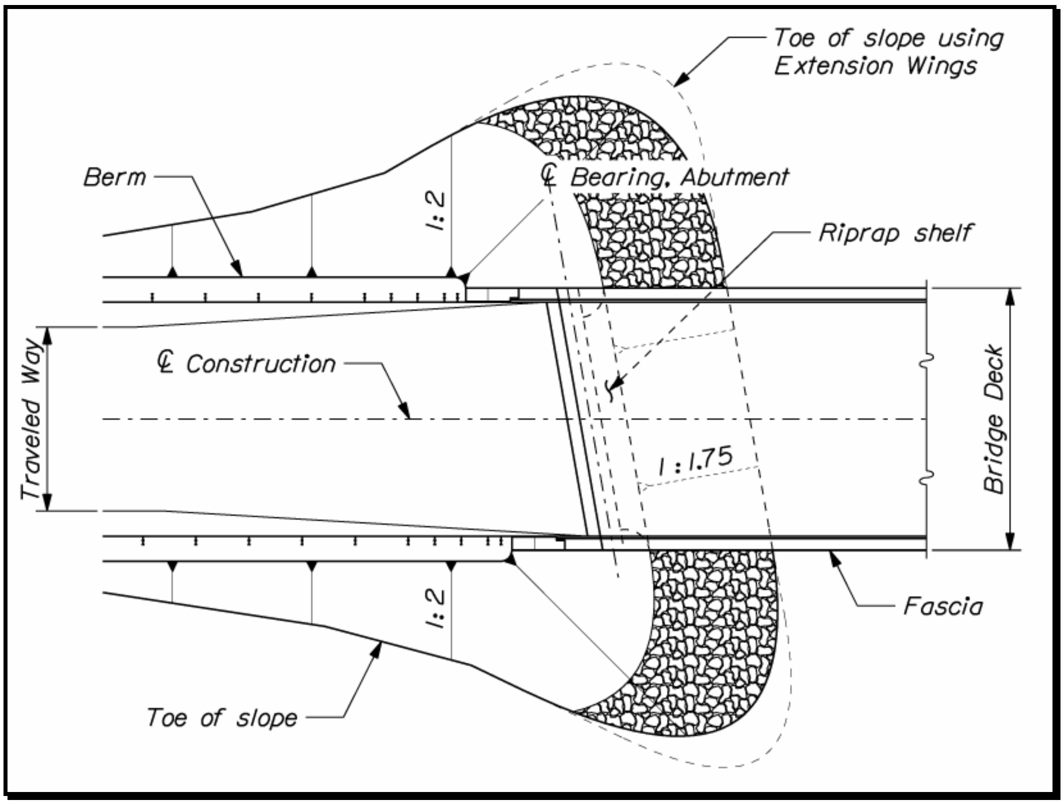


Figure 3-8 Return Wing Plan

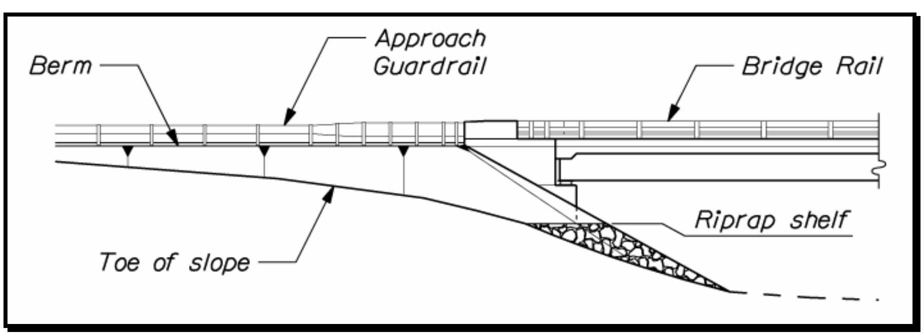


Figure 3-9 Return Wing Elevation

3.2.4.4 Flared Wings

The "ideal" flared wing bisects the angle between the centerline of bearing and the roadway berm. (The occasionally used expression "45 degree wing" is proper only if the bridge has no skew.) Flared wings result in the best balance between structure cost and embankment fill requirements and so are by far the most widely used wing configuration.

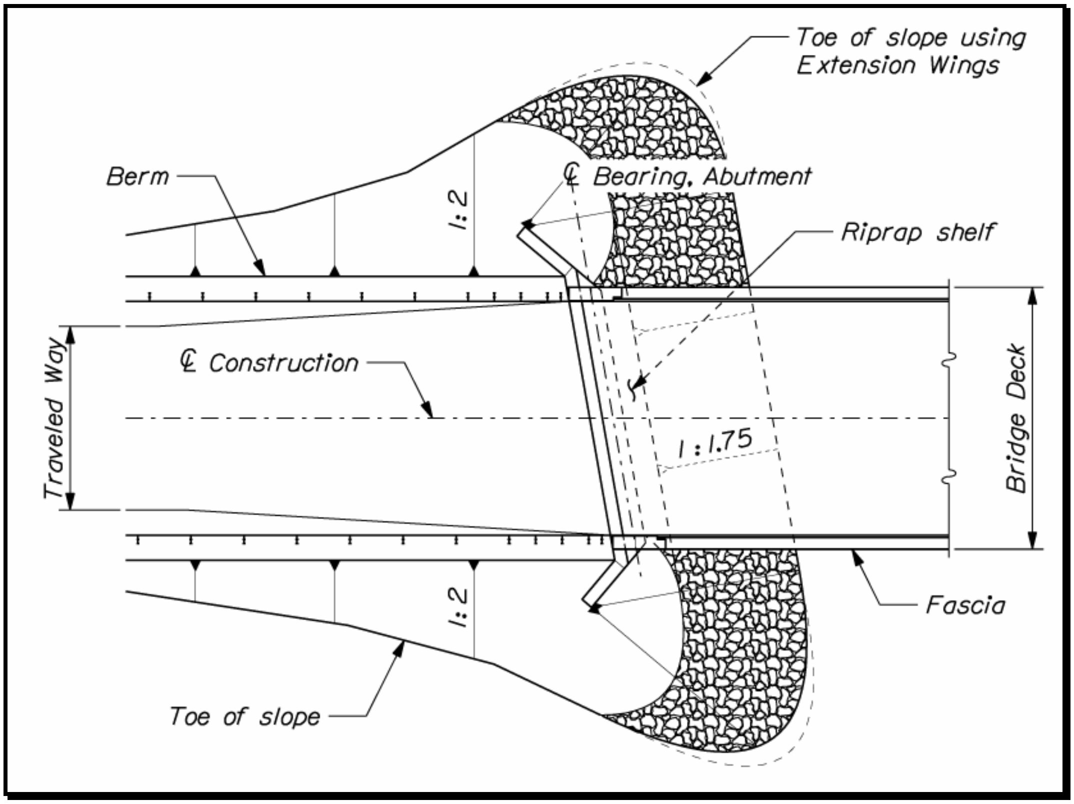


Figure 3-10 Flared Wing Plan

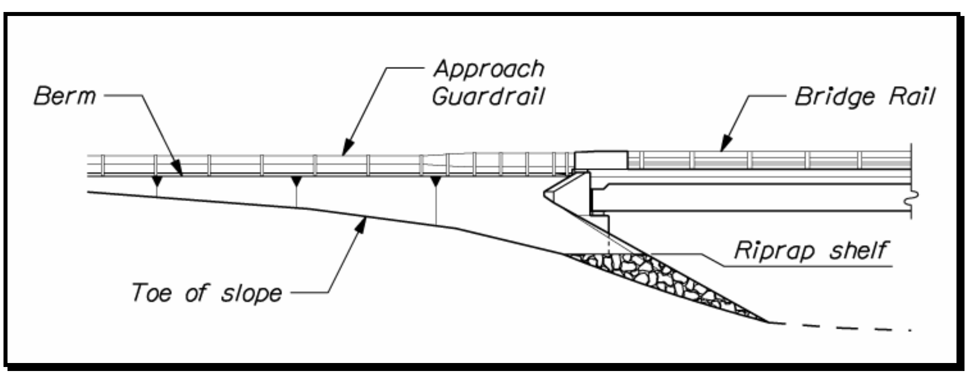
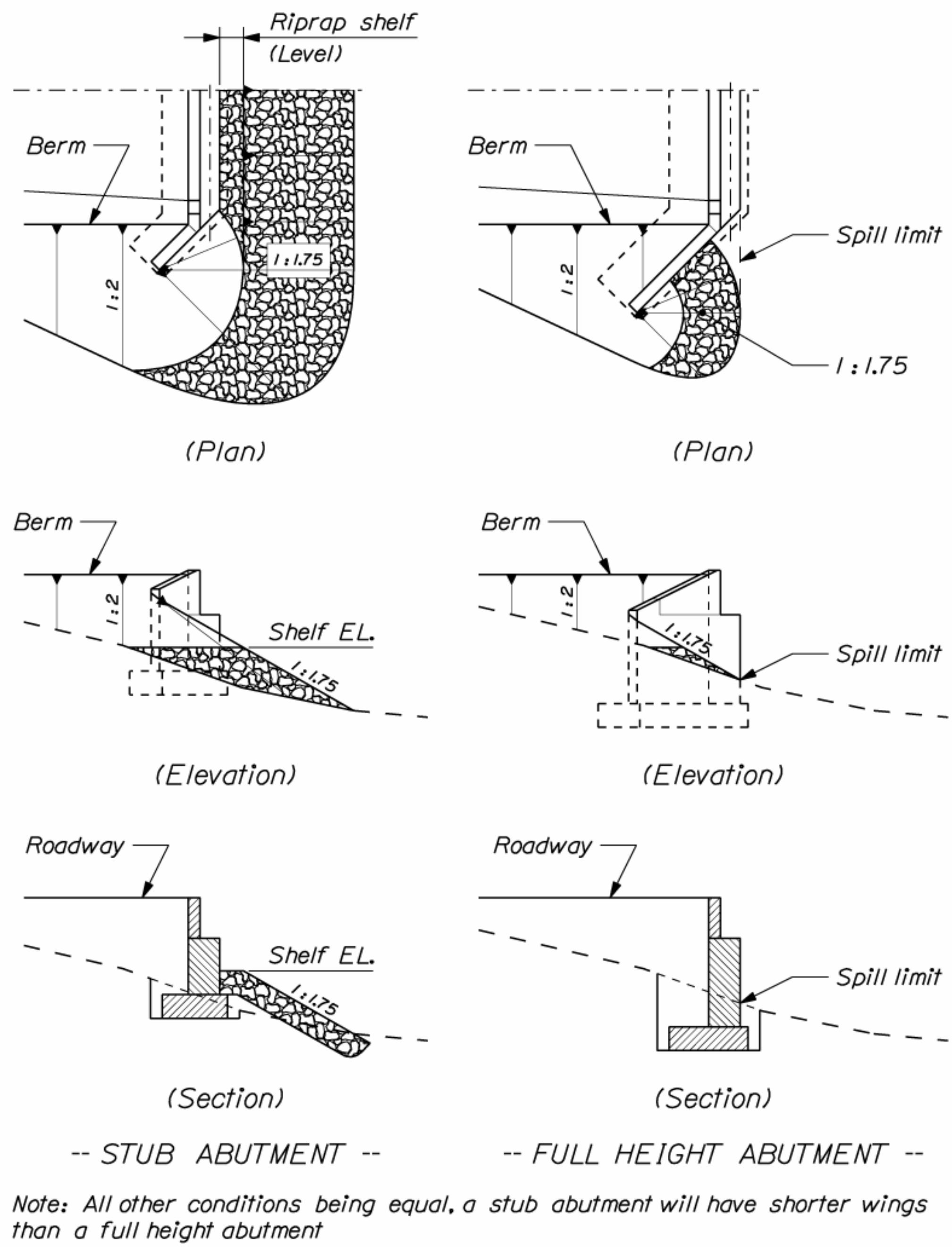


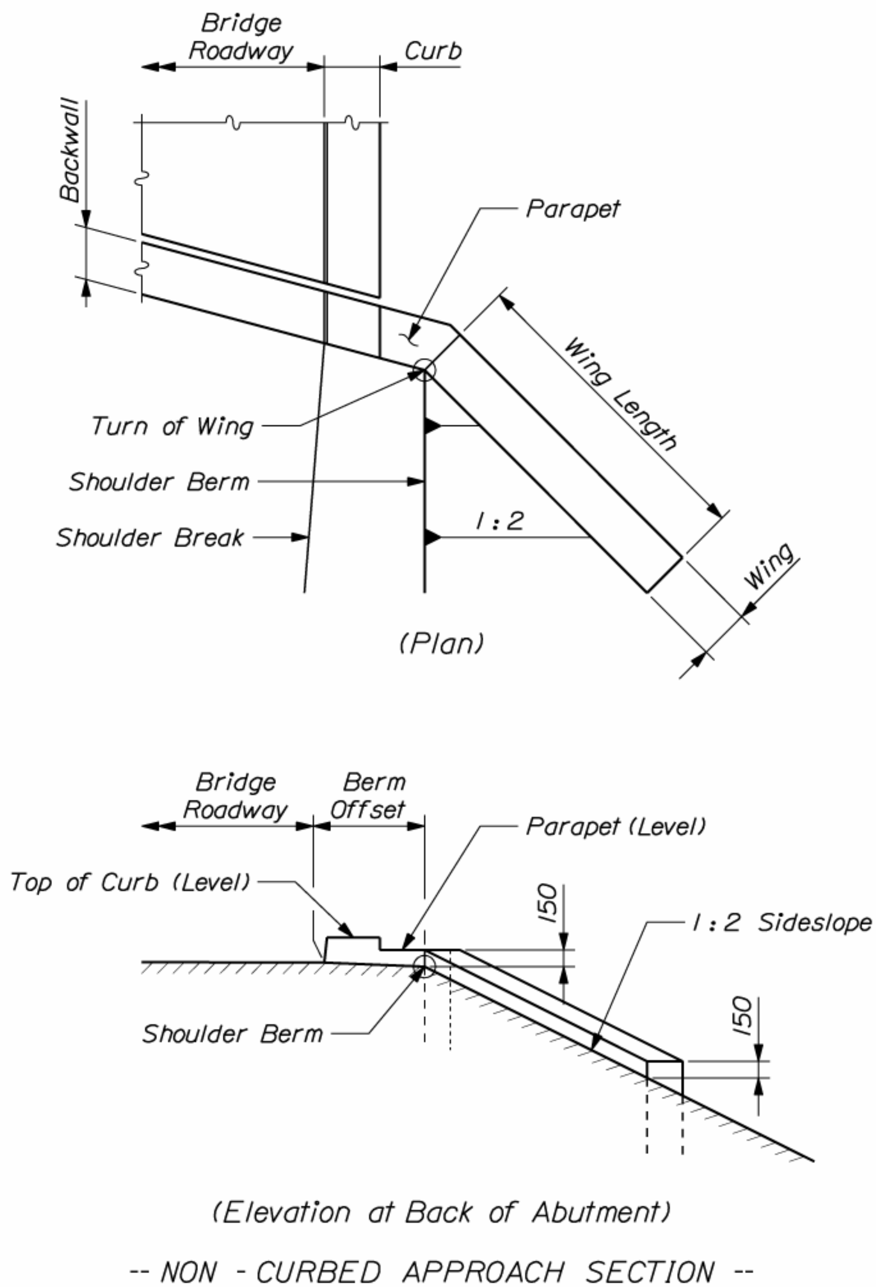
Figure 3-11 Flared Wing Elevation

A. General Flared Wing Layout



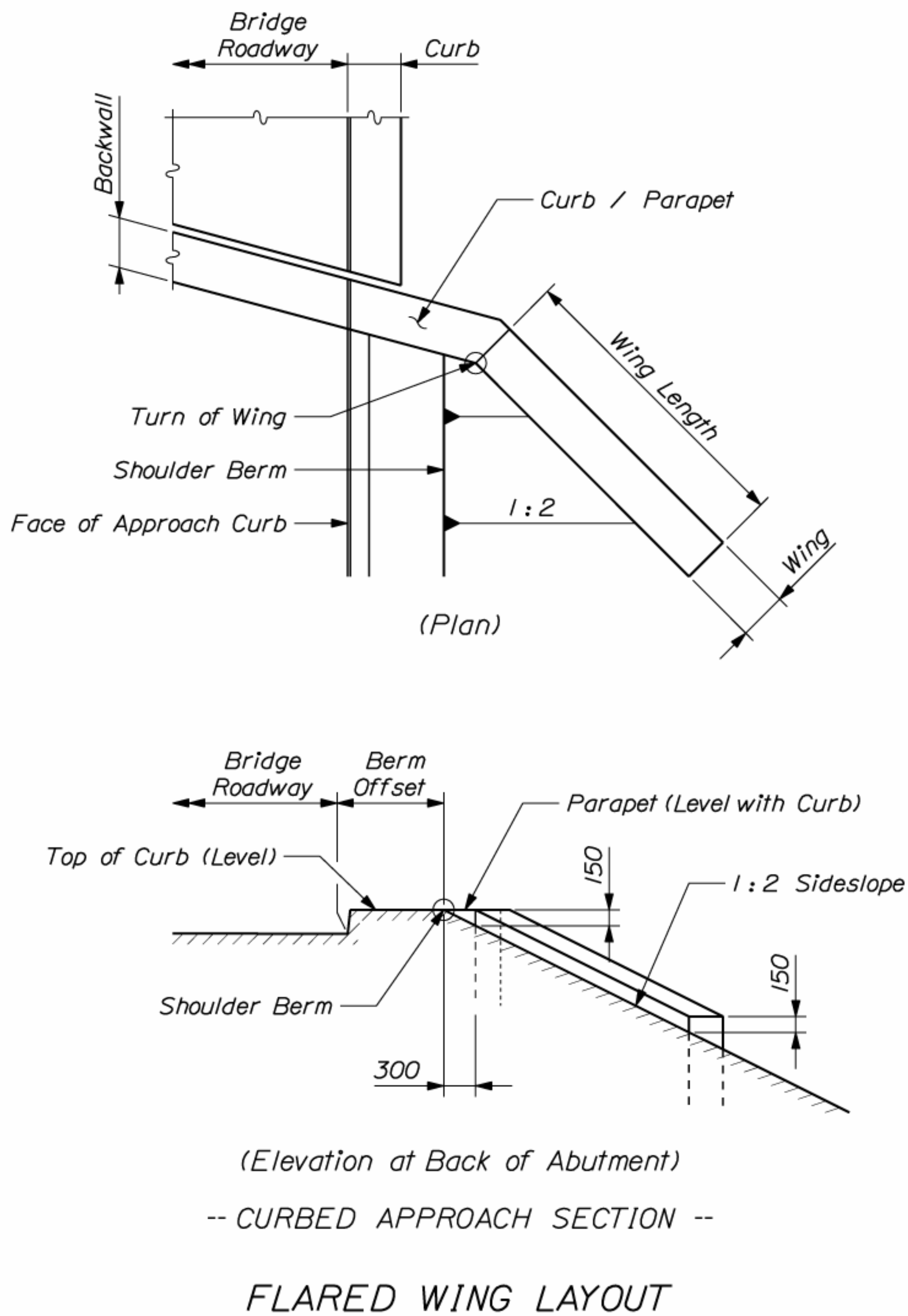
FLARED WING LAYOUT

B. Flared Wing on Non-Curbed Approach

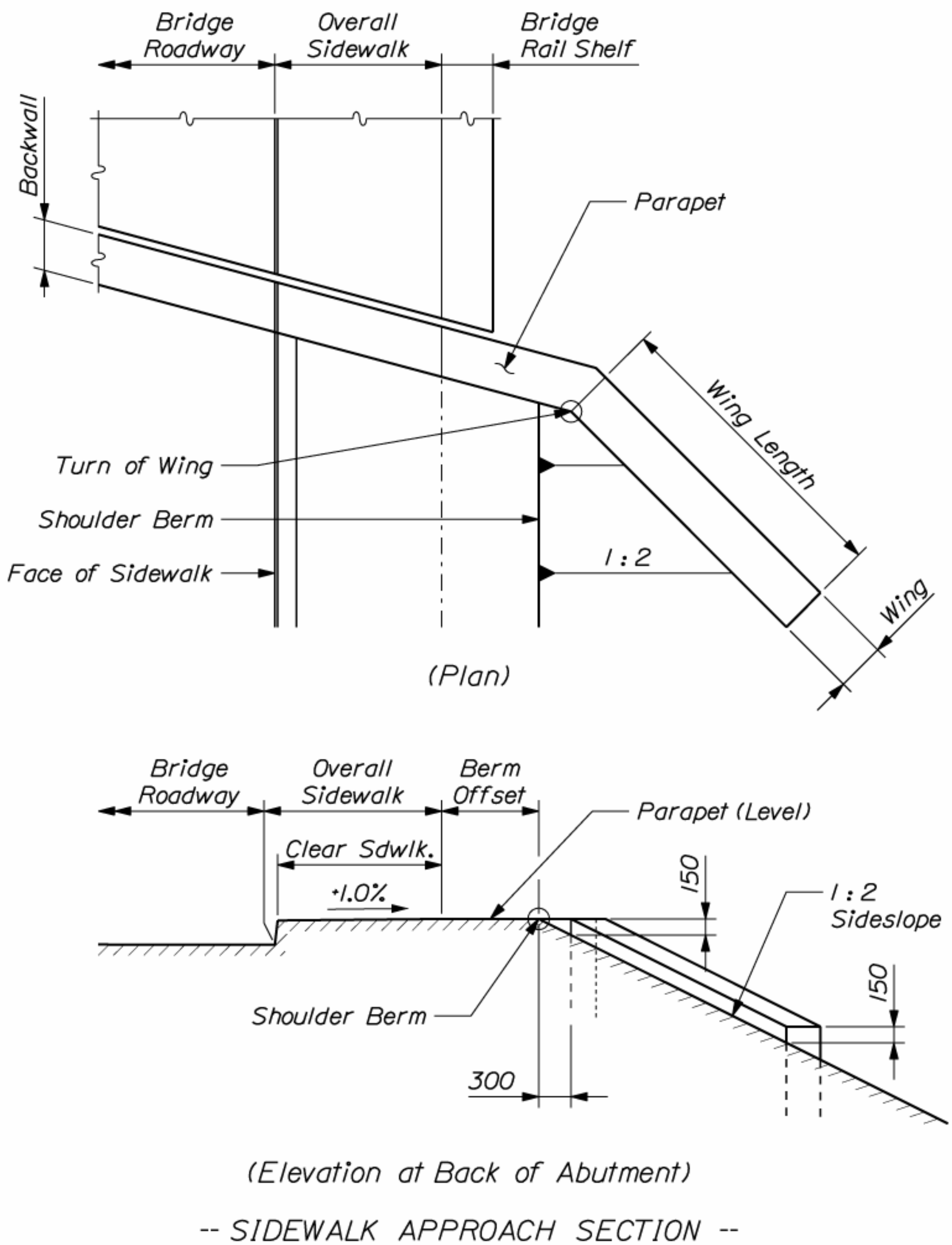


FLARED WING LAYOUT

C. Flared Wing on Curbed Approach

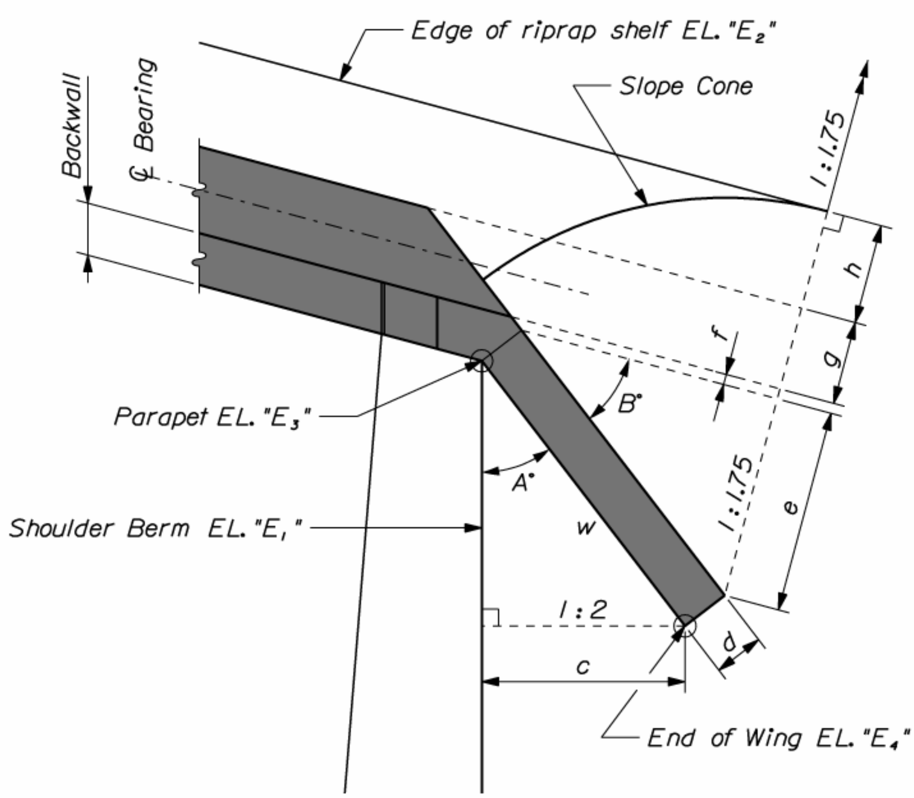


D. Flared Wing on Sidewalk Approach



FLARED WING LAYOUT

E. Layout of Flared Wings for Stub Abutment with Riprap Shelf



-- PLAN --
(Stub abutment with riprap shelf)

NOTES:

1. Typically A° = B° unless site conditions warrant otherwise.
2. Dim. "d" = Wing thickness
3. Dim. "f" varies depending on wing angle and wall thicknesses.
4. Dim. "g" = Bridge seat width
5. Dim. "h" = Riprap shelf width
6. Dim "w" = Wing length calculated from given criteria.

FLARED WING LAYOUT

EXAMPLE CALCULATIONS
(Stub abutment with riprap shelf)

Given: Skew Angle = 15°
Berm EL. "E_1" = 28.180
Riprap Shelf EL. "E_2" = 25.000

Assume A° = B°
Dim. "d" = 0.450 m
Dim. "f" = 0.093 m (Measured or calculated)

Then: Wing angle A° = B° = (90° - 15°)/2 = 37.5°
Change in elevation $\Delta E = E_1 - E_2$ = 28.180 - 25.000 = 3.180
c = (sin A) w
e = (sin B) w

WING LENGTH (Round to nearest 0.150 m)

$$\Delta E = \frac{(\sin A)\,w}{2} + \frac{d}{1.875} + \frac{(\sin B)\,w}{1.75} + \frac{(f + g + h)}{1.75}$$

$$3.180 = \frac{(\sin 37.5)\,w}{2} + \frac{0.450}{1.875} + \frac{(\sin 37.5)\,w}{1.75} + \frac{(0.093 + 0.750 + 0.900)}{1.75}$$

$$3.180 = 0.304\,w + 0.240 + 0.348\,w + 0.996$$

$$1.944 = 0.652\,w$$

$$2.982 = w$$

→ Use Wing Length = 3.000 m

PARAPET ELEVATION (Round up to 0.005 m)

$$E_3 = E_1 + 0.150$$

$$= 28.180 + 0.150 = 28.330$$

→ Use Parapet EL. 28.330

FLARED WING LAYOUT

EXAMPLE CALCULATIONS
(Stub abutment with riprap shelf)

END OF WING ELEVATION (Round up to 0.005 m)

$$E_4 = E_1 - \frac{(\sin A)\,w}{2} + 0.150$$

$$= 28.180 - \frac{(\sin 37.5)\,3.000}{2} + 0.150$$

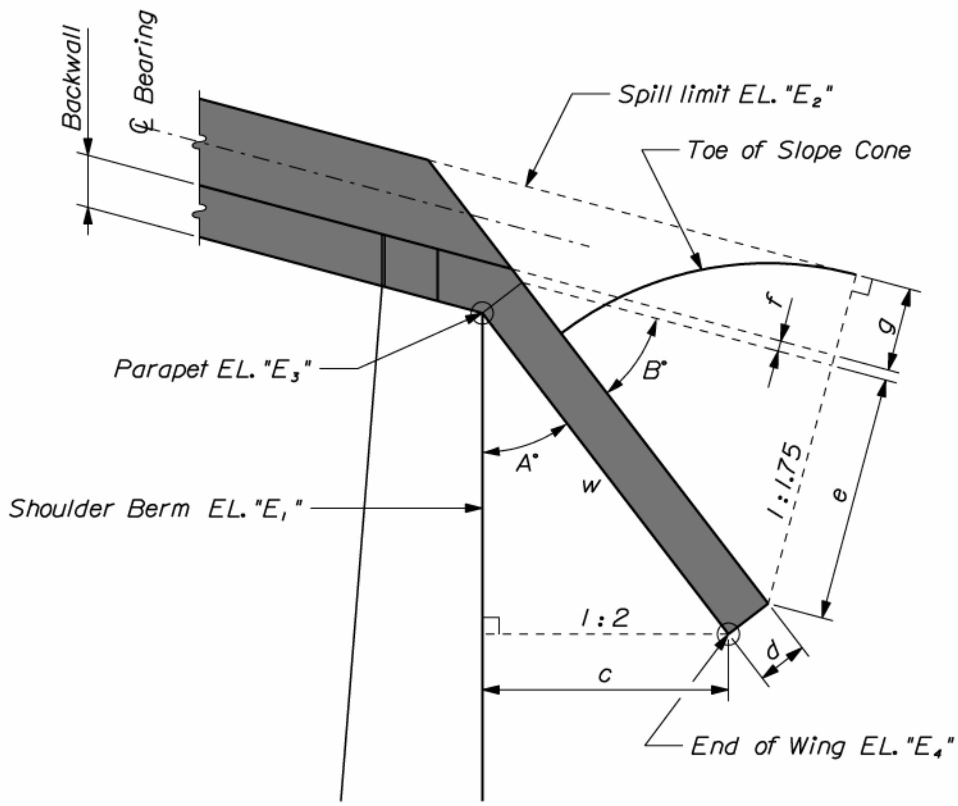
$$= 28.180 - 0.913 + 0.150$$

$$= 27.417$$

→ Use End of Wing EL. 27.420

FLARED WING LAYOUT

F. Layout of Flared Wings for Full Height Abutment with no Shelf



-- PLAN --
(Full height abutment with no shelf)

NOTES:

1. Typically A° = B° unless site conditions warrant otherwise.
2. Dim. "d" = Wing thickness
3. Dim. "f" varies depending on wing angle and wall thicknesses.
4. Dim. "g" = Bridge seat width
5. Dim "w" = Wing length calculated from given criteria.

FLARED WING LAYOUT

EXAMPLE CALCULATIONS
(Full height abutment with no shelf)

Given: Skew Angle = 15°
Berm EL. "E_1" = 28.180
Spill limit EL. "E_2" = 23.500

Assume $A^\circ = B^\circ$
Dim. "d" = 0.450 m
Dim. "f" = 0.093 m (Measured or calculated)

Then: Wing angle $A^\circ = B^\circ = (90^\circ - 15^\circ)/2 = 37.5^\circ$
Change in elevation $\Delta E = E_1 - E_2 = 28.180 - 23.500 = 4.680$
$c = (\sin A)\, w$
$d = (\sin B)\, w$

WING LENGTH (Round to nearest 0.150 m)

$$\Delta E = \frac{(\sin A)\, w}{2} + \frac{d}{1.875} + \frac{(\sin B)\, w}{1.75} + \frac{(f + g)}{1.75}$$

$$4.680 = \frac{(\sin 37.5)\, w}{2} + \frac{0.450}{1.875} + \frac{(\sin 37.5)\, w}{1.75} + \frac{(0.093 + 0.750)}{1.75}$$

$$4.680 = 0.3044\, w + 0.240 + 0.3479\, w + 0.482$$

$$3.958 = 0.652\, w$$

$$6.070 = w$$

→ Use Wing Length = 6.000 m

PARAPET ELEVATION (Round up to 0.005 m)

$$E_3 = E_1 + 0.150$$

$$= 28.180 + 0.150 = 28.330$$

→ Use Parapet EL. 28.330

FLARED WING LAYOUT

EXAMPLE CALCULATIONS
(Full height abutment with no shelf)

END OF WING ELEVATION (Round up to 0.005 m)

$$E_4 = E_1 - \frac{(\sin A)\,w}{2} + 0.150$$

$$= 28.180 - \frac{(\sin 37.5)\,6.000}{2} + 0.150$$

$$= 28.180 - 1.826 + 0.150$$

$$= 26.504$$

→ *Use End of Wing EL. 26.505*

FLARED WING LAYOUT

3.2.5 Typical Sheet Names and Contents

3.2.5.1 ABUTMENT NO. X FOOTING

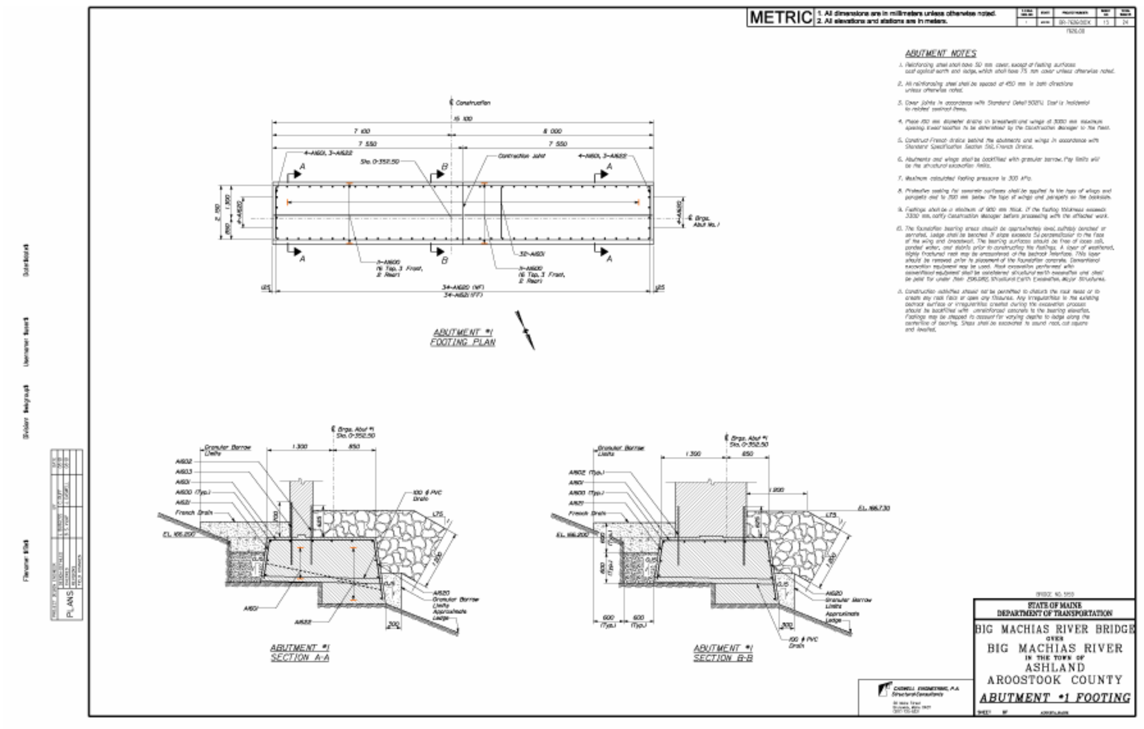


Figure 3-12 Abutment Footing Sheet

Use when abutments have footings and/or seals that won't fit sheeted up with the abutment plan and elevation.

Will Contain:

1) Footing Plan

May Contain:

1) Footing Section
2) Seal Plan
3) Abutment Notes
4) Pile Notes
5) Seal/Cofferdam Notes

3.2.5.2 Abutment No. X

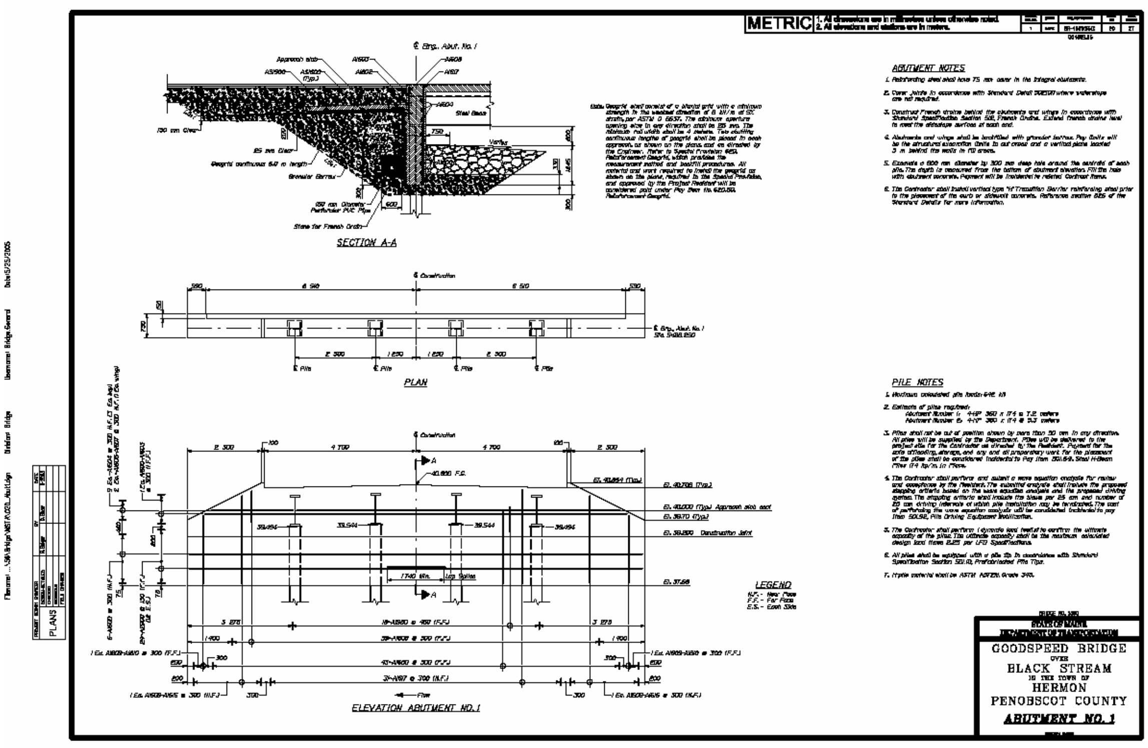


Figure 3-13 Abutment Sheet

All jobs with two different abutments will have an Abutment No. 1 sheet and an Abutment No. 2 sheet. If both abutments are geometrically the same you can show both abutments with one set of details. Check with an experienced detailer before proceeding with this approach.

Will Contain:

1) Abutment Plan (may be cut at ends of breastwall, if so, show wing plan on wing sheet.)
2) Abutment Elevation (may be cut at ends of breastwall)
3) Typical Abutment Section

May Contain:

1) Abutment Notes
2) Pile Notes
3) Seal/Cofferdam Notes
4) Wing Section
5) Footing Plan
6) Additional Sections

3.2.5.3 Abutment No. X Wings

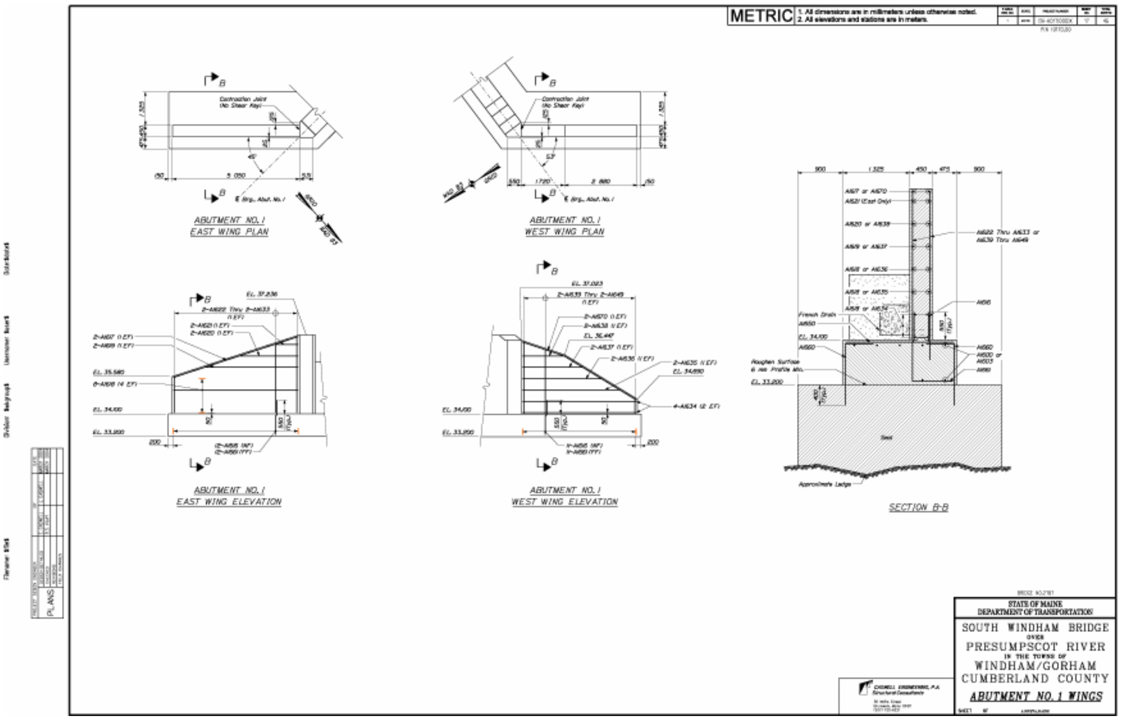


Figure 3-14 Abutment Wings Sheet

Use when abutment wings don't fit on abutment plan.

Will Contain:

1) Wing Elevation
2) Wing Section

May Contain:

1) Wing Plan
2) Add'l Special Details, i.e. wing turn blowup

> ⓘ **Abutments for precast box - type superstructures shall be detailed with a horizontal construction joint at the elevation of the bridge seats to aid in the erection of the superstructure and assure correct fit at the parapets.**

3.2.6 Standard Notes

3.2.6.1 Abutment Notes

1) Reinforcing steel shall have a minimum concrete cover of 2 inches cover in the walls and 3 inches in the footings unless otherwise noted.
2) Cover joints where waterstops are not required in accordance with Standard Detail 502 (01).

3) Place 4 in. diameter drains in breastwall and wings at XX feet maximum spacing. Exact location to be determined by the Resident in the field.
4) Construct French Drains behind the abutments and wingwalls in accordance with Standard Specifications Section 512, French Drains.
5) Structural Earth Excavation, Abutments and Retaining Walls, required more than 12 inches below the bottom of the structure will be paid for in accordance with Standard Specifications Section 206 Structural Excavation.
6) Abutments, wings, and their footings shall be backfilled with Granular Borrow. Pay limits will be the structural excavation limits in cut areas and a vertical plane located 10 feet behind the walls in fill areas.
7) Maximum calculated footing pressure is XX tons per square foot.

(The following note is used with pile-supported integral abutments.)

8) Excavate a 24-in. diameter by 12-in. deep hole around the centroid of each pile. The depth is measured from the bottom of the abutment. Fill the hole with abutment concrete. Payment for all labor and materials will be considered incidental to related Contract items.

(The following note is used with precast box or slab type superstructures)

9) To ensure an accurate match with the superstructure, the parapet portions of the wingwalls shall be placed after erection of the precast units.

(The following note is used when Transition Barriers are constructed on return wingwalls)

10) The Contractor shall install Transition Barrier vertical closed stirrups, as shown in the Standard Details Section 526, prior to the placement of the curb concrete.

3.2.6.2 Pile Notes

1) Piles marked with an arrow shall be battered XX% in the direction of the arrow.
2) Maximum calculated pile loads: XX kips (including XX kips allowed for negative skin friction).
3) Estimate of piles required:

Abutment Number 1:	XX~HP XX x XX @ XX feet
Abutment Number 2:	XX~HP XX x XX @ XX feet
Pier Number 1:	XX~HP XX x XX @ XX feet
Pier Number 2:	XX~HP XX x XX @ XX feet

4) HP 13 x XX bearing piles may be substituted for HP 14 x XX (HP 12 x XX) bearings piles at the option of the Contractor.

(The following note is used for integral abutments with steel stringers.)

5) Piles shall not be out of position shown by more than 2 inches in any direction.

(The following two notes are used for pile-supported foundations. The Geotechnical Designer will make a recommendation for their use or exclusion. The Structural Designer should determine the appropriate pay item and the Geotechnical Designer determine the number of dynamic tests.)

6) The Contractor shall perform and submit a wave equation analysis for review and acceptance by the Resident. The Contractor shall determine a stopping criteria based on the wave equation analysis. The stopping criteria shall include the blows per inch and the number of 1 inch intervals at which pile installation may be terminated. The cost of performing the wave equation analysis will be considered incidental to pay Item 501.92, Pile Driving Equipment Mobilization.
7) The ultimate capacity shall be the maximum calculated design load times 2.25 per LFD Specifications. The Contractor shall perform XX dynamic load test(s) to confirm the ultimate capacity of the piles. The dynamic test shall be performed on the first production pile driven.
8) All piles shall be equipped with a pile tip in accordance with Standard Specification Section 501.10, Prefabricated Pile Tips.
9) H-pile material shall be ASTM A 572, Grade 50.
10) Pipe pile material shall be ASTM A 252 Grade 2 or 3.

3.2.7 Detail Checklists

3.2.7.1 Footing Plan

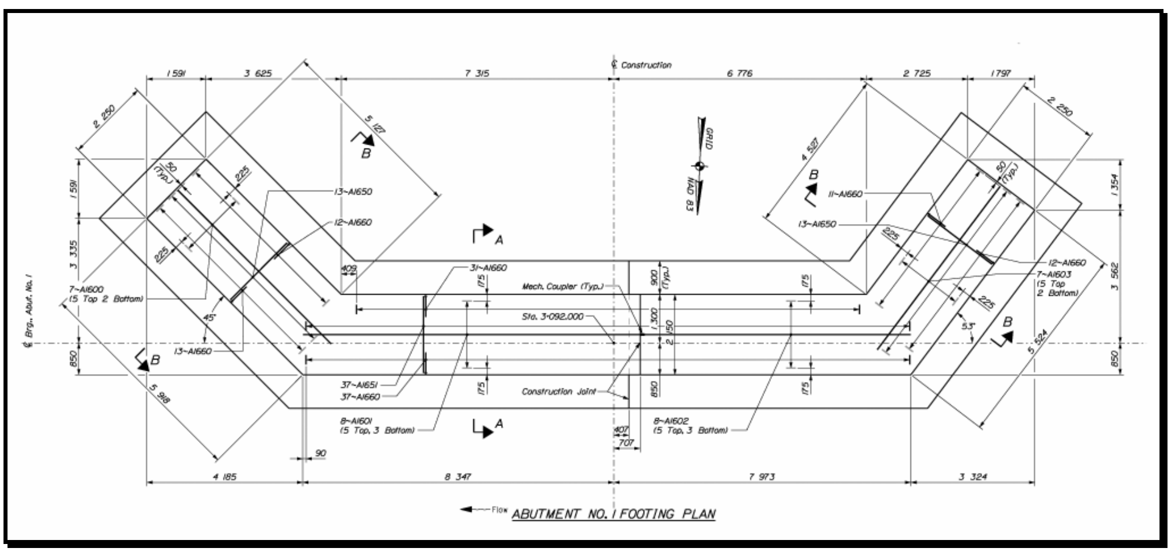


Figure 3-15 Abutment Footing Plan

Intro: Top view of abutment footing. Unlike abutment plan, the abutment footing plan shows reinforcing steel.

Sheet-up: Belongs in the upper left of an abutment footing sheet. If it will fit on an abutment sheet above the abutment plan and elevation, it may be included there as well.

Scale: ¼”

Draw:

1) Limits of concrete
2) Piles
3) Vertical Joints (do not show shear key)
4) Centerline of Bearing
5) Centerline of Construction / Working Line
6) Centerline of Piles (if different than CL Bearing)
7) Reinforcing steel
8) Limits of Seal

Dimension:

1) Limits of concrete. Each point should be located from the working point in two directions: parallel and perpendicular to the centerline of bearing.
2) Footing Width(s)
3) Wing footing length
4) Joint locations
5) Pile locations
6) Angle of wing footing turn
7) Skew angle of CL Bearing to Working Line/CL Construction
8) Location of Seal relative to limits of footing

Label:

1) North
2) Flow
3) All Centerlines (Bearing, Construction, Working Lines)
4) Detail Name "Footing Plan"
5) Station of Working Point (intersection of CL Bearing and CL Construction)
6) Reinforcing steel
7) Joints
8) Detail/Section Cuts
9) Pile Batter Direction

3.2.7.2 Footing Section

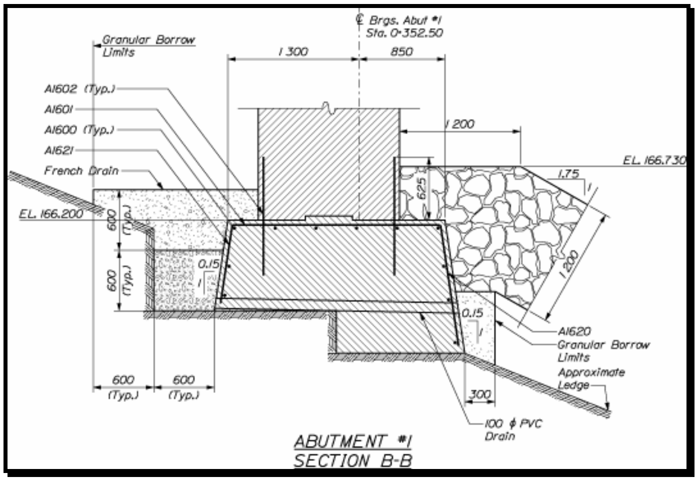


Figure 3-16 Abutment Footing Section

Intro: Sections must be cut on the abutment footing plan. They are used to show abutment footing thickness, reinforcing steel, and to clarify concrete limits. They may also be used to show earthwork limits.

- ♬ Sections should always be cut from the right side of the project looking left, such that left on the section is downstation, right is upstation.

Sheet-up: Section belongs on the same sheet as the footing plan.

Scale: ½”

Draw:

1) Concrete limits (new placements of concrete should be hatched at 45 or 135 degrees, with adjacent separate placements hatched alternately)
2) Centerline of Bearing
3) Horizontal construction joints (show shear keys)
4) Piles
5) Ledge line
6) Reinforcing Steel
7) If they can’t be shown on abutment section, show French Drains and Backfill limits.
8) Weepers

Dimension:

1) Thickness of the footing, referenced to the CL Bearing
2) Reinforcing dowel embedments/projections and lap splices
3) Non-typical reinforcing cover (i.e. at bottom of footing)
4) Pile Embedment into footing

5) Earthwork limits (only if it can't be shown on abutment section)

Label:

1) CL Bearing
2) Detail Name
3) Non-standard Chamfer sizes
4) Ledge should be labeled "Approximate Ledge"
5) Rise/Run of all slopes (battered faces of concrete, piles, limits of backfill, etc.)
6) Reinforcing Steel
7) Weepers
8) Piles (generic label, i.e. "H Pile", w/o specific designation)
9) Any horizontal construction joint w/o a shear key needs to be roughened. Point to the surface and label "Roughen surface ¼" profile min."
10) Backfill material, if shown (French Drain, borrow, etc.)
11) Pay Limits, if shown (Structural earth excavation, Granular borrow, Gravel borrow, etc.)

3.2.7.3 Abutment Plan

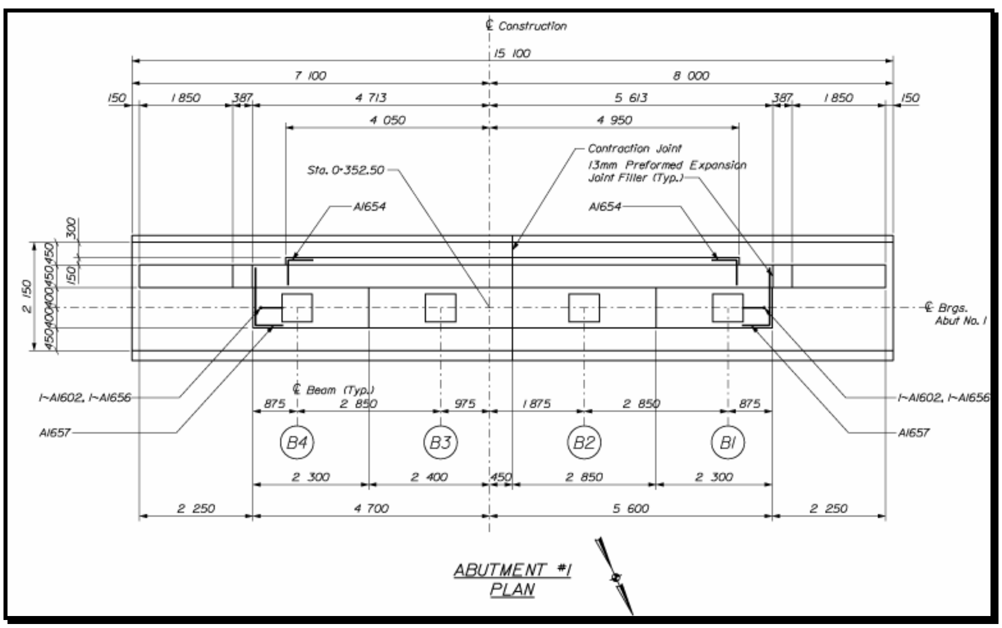


Figure 3-17 Abutment Plan

Intro: Top view of abutment, showing the relationship to the working lines. Plans should include breastwall and wings unless there isn't room.

Sheet-up: Belongs in the upper left of abutment sheet, directly above Abutment Elevation, with centerlines aligned.

Scale: ¼". Smaller scales are acceptable for large abutments.

Draw:

1) Limits of concrete (breastwall, wings, footing, approach slab seat)
2) Outline of steel girder bearings
3) Parapets
4) Vertical Joints (do not show shear key)
5) Do not show hidden lines for shear keys in horizontal joints
6) Centerline Bearing of Abutment
7) Centerline of Construction / Working Line
8) Centerline of girders
9) Any steps in top of breastwall bearing seats
10) May draw reinforcing steel that can't be shown in elevation and section (i.e. horizontal Ls at end of approach slab seat and/or breastwall). Otherwise, no reinforcing steel is shown in this plan.

Dimension:

1) Limits of concrete. Each point should be located from the working point in two directions: parallel and perpendicular to the centerline of bearing. Include wings, breastwall, approach slab seat, parapets, etc.
2) Wing length
3) Any steps in top of breastwall bearing seats.
4) Joint locations
5) Pile locations
6) Bearing locations
7) Angle of wing turn
8) Skew angle of CL Bearing to Working Line/CL Construction

Note that typically the abutment and wing wall is best shown in section rather than on the plan view.

Label:

1) North
2) Flow
3) All Centerlines (Bearing, Construction, Working Lines, Girders)
4) Detail Name "Plan"
5) Station of Working Point (create a ¼ inch circle around the intersection of CL Bearing and CL Construction and pull a leader off labeling the station)
6) Label any reinforcing steel shown in plan.
7) Joints

8) Preformed expansion joint filler
9) Approach Slab Seat
10) Detail/Section Cuts

3.2.7.4 Abutment Elevation

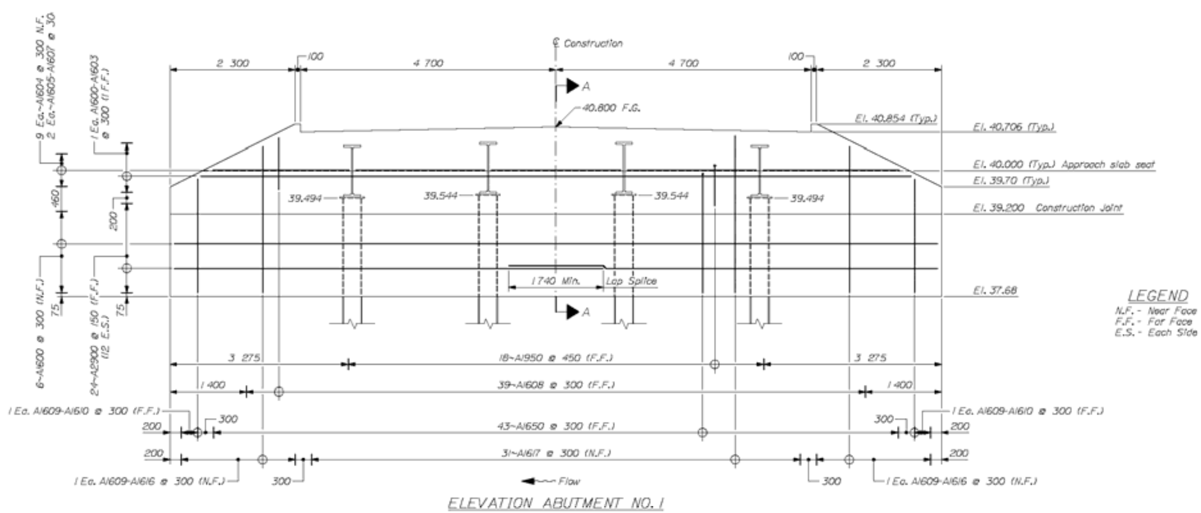


Figure 3-18 Abutment Elevation

Intro: Front view projection of abutment. Abutment No. 1 always shown looking down station, Abutment No. 2 shown looking up station. This detail is primarily for showing reinforcing and elevations.

Sheet-up: Belongs on left bottom of abutment sheet, directly below the plan with centerline/working points aligned.

Scale: should always be the same scale as the abutment plan, typically ¼"

Draw:

1) Limits of concrete (breastwall, wings, footing, seal, backwall, bearings, parapets, approach slab seat)

2) Piles (for integral abutments, but not for pile-supported footings)
3) Concrete turn points.
4) Ledge line
5) Vertical and Horizontal Joints
6) Hidden lines for far face concrete limits
7) Centerline of Construction/Working Line
8) Reinforcing steel
9) Utility openings

Dimension

1) Utility openings are generally dimensioned to the Centerline/Working Line
2) Location of vertical reinforcing steel relative to nearest concrete limit.
3) Projection/Embedment lengths of reinforcing dowels (only if unable to clearly show in section)
4) Lap/Splice lengths of reinforcing tied to dowels (only if unable to clearly show in section)

Label

1) Elevations for top of seal, top of footing, end of wing, top of parapet, bridge seats, top of backwall (label NF and FF), utility openings, horizontal construction joints, top of approach slab seat.
2) Reinforcing Steel
3) Section and Detail Cuts
4) Detail Name "Elevation"
5) Joints (Horizontal and Vertical, Construction, Contraction, Expansion)
6) CL of Construction at CL of Bearings

3.2.7.5 Abutment Sections (Breastwall, Wing)

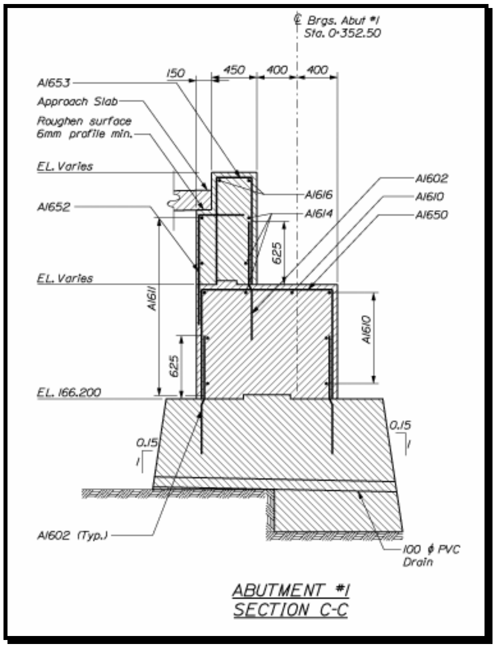


Figure 3-19 Abutment Section

Intro: Sections must be cut on the abutment plan and elevation. They are used to show abutment thickness, reinforcing steel, and to clarify concrete and earthwork limits.

♬ Sections should always be cut from the right side of the project looking left, such that the left of the section is downstation, the right is upstation.

Sheet-up: Breastwall section belongs on the same sheet as the abutment plan and elevation. Wing sections go either with the breastwall section or on a separate wing sheet, depending on room.

Scale: ½”

Draw:

1) Concrete limits (new placements of concrete should be hatched at 45 or 135 degrees, with adjacent separate placements hatched alternately)
2) Centerline of Bearing
3) In some cases you’ll show the superstructure in the vicinity of the abutment (i.e. integral abutments)
4) Membrane waterproofing (for integral abutments)
5) Horizontal construction joints (show shear keys)
6) Piles
7) Ledge line
8) Reinforcing Steel

9) Approach Slab
10) French Drains
11) Weepers
12) Backfill limits (pattern backfill areas)
13) Riprap (pattern limits)
14) In the case of return wings, you may need to show bridge rail or guard rail mounted on the wings.

Dimension:

1) Thickness of the abutment, referenced to the CL Bearing
2) Reinforcing dowel embedments/projections and lap splices
3) Membrane Waterproofing limits
4) Non-typical reinforcing cover (i.e. at bottom of footing)
5) Pile Embedment into footing/breastwall
6) Earthwork limits
7) Riprap thickness
8) Width of shelf in front of abutment
9) Vertical clearance from superstructure to shelf (integral abutments only)

Label:

1) CL Bearing
2) Detail Name
3) Shelf elevation
4) Approach Slab
5) Membrane Waterproofing
6) Non-standard Chamfer sizes
7) Ledge should be labeled "Approximate Ledge"
8) Rise/Run of all slopes (battered faces of concrete, piles, finished grade of riprap, limits of backfill, etc.)
9) Reinforcing Steel
10) Weepers
11) Piles (generic label, i.e. "H Pile", w/o specific designation)
12) Approach slab seat (and any horizontal construction joint w/o a shear key) needs to be roughened. Point to the surface and label "Roughen surface ¼" profile min."
13) Backfill material (French Drain, borrow, etc.)
14) Pay Limits (Structural earth excavation, Granular borrow, Gravel borrow, etc.)

15) Pay Limits of Superstructure concrete (integral abutments only)

3.2.7.6 Wing Plan

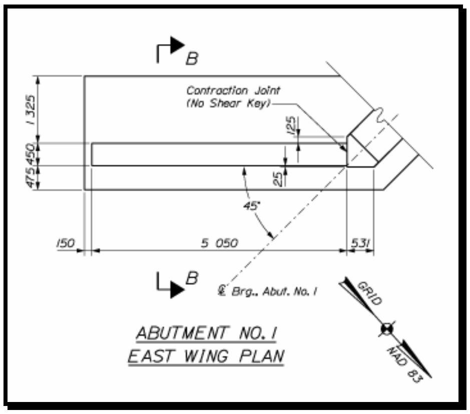


Figure 3-20 Abutment Wing Plan

Intro: If an abutment has wings of a length that makes it difficult to show on the abutment plan, a separate wing plan can be drawn. Refer to the Abutment Plan requirements, above, for what information needs to be drawn, dimensioned and labeled.

Sheet-up: typically, wing plans will not fit on the same sheet as the abutment plan and elevation, and will require the creation of a wing sheet.

Scale: ¼"

3.2.7.7 Wing Elevation

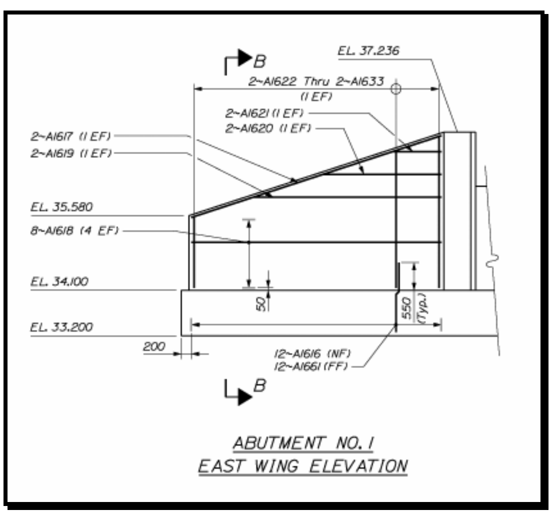


Figure 3-21 Abutment Wing Elevation

Intro: Any flared or return wing will require a wing elevation to be shown. Refer to the Abutment Elevation requirements, above, for what information needs to be drawn, dimensioned and labeled.

Sheet-up: typically, wing elevations will not fit on the same sheet as the abutment plan and elevation, and will require the creation of a wing sheet.

♬ It isn't always necessary to show a wing plan when you show a wing elevation. If the full geometry of the wing can be shown in the abutment plan, do not duplicate that information on the wing sheet.

Scale: ¼"

3.2.7.8 Wing Joint Detail

Intro: Whenever a horizontal construction joint intercepts the top of a sloping wing, the joint must be turned perpendicular to the sloping surface of the wing to prevent a feathered edge. Because a horizontal construction joint requires a shear key, it is also necessary to add this joint to prevent that shear key from intersecting the sloping top surface of the wing.

Sheet-up: This detail should be shown on a sheet where wing sections and elevations are being shown.

Scale: try 1" or 1 ½"

Draw:

1) Construction Joint
2) Sloping Surface of Wing
3) Any other line work (hidden lines for shear key)

Dimension:

1) How far below the surface the construction joint turns (Depends on slope of the wing, start at 3")
2) Angle of incidence of joint to wing (90 degrees)

Label:

1) Construction Joint
2) Detail Name

3.2.7.9 Pile Cap Plate Detail

Intro: On integral abutments, it is necessary to detail the connection between steel stringers and steel piles.

Sheet-up: This detail should be shown on a sheet that contains the breastwall section.

Scale: Start with ¾" or 1"

Draw:

1) Pile
2) Stringer
3) Cap Plate

Dimension:

1) Relationship of plate to CL of Pile

Label:

1) Cap Plate to Pile Weld
2) Cap Plate to Girder Weld
3) Size of plate

3.3 Piers

3.3.1 Introduction

3.3.1.1 Foundation Types

A. Cofferdam and Seal

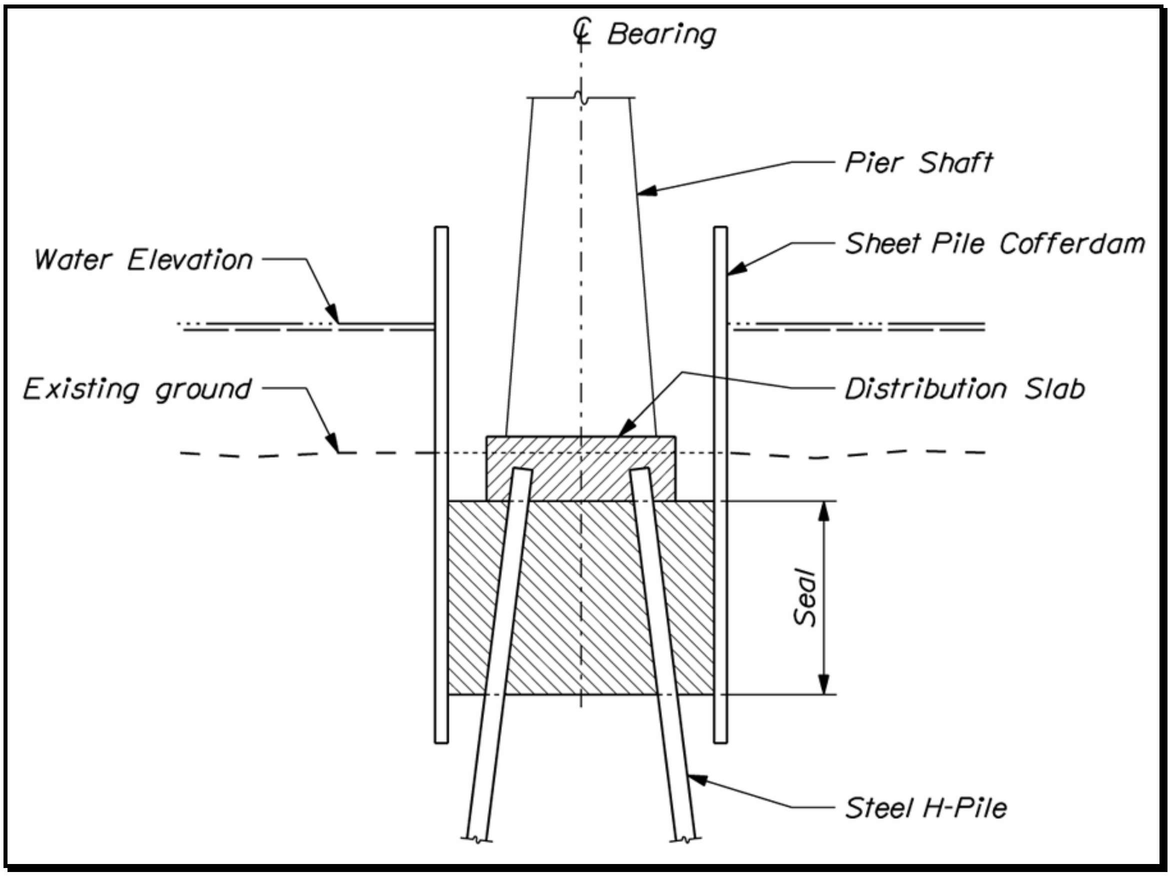


Figure 3-22 Cofferdam and Seal Foundation

B. Pile Bent

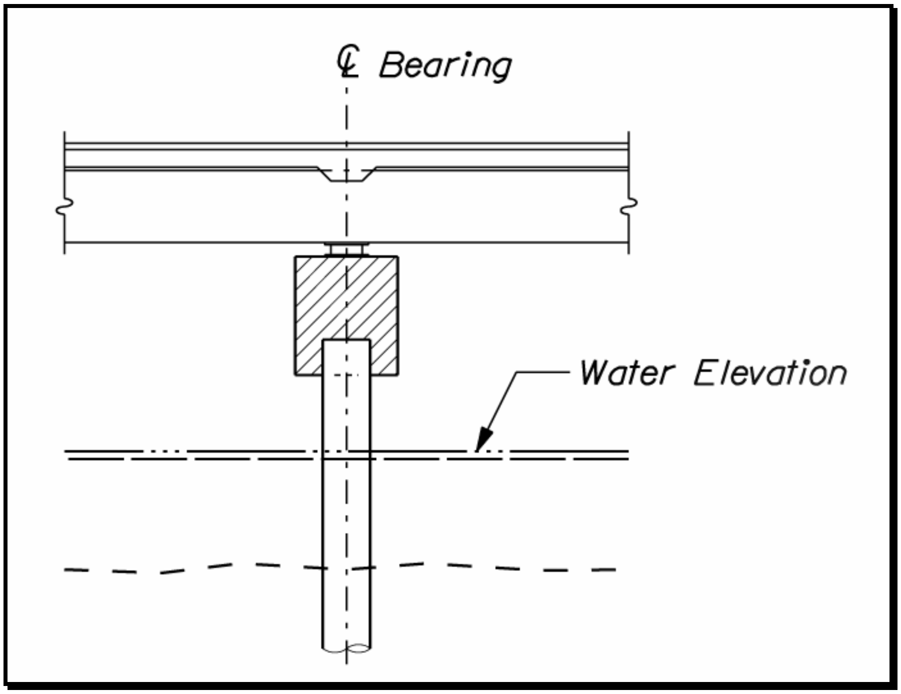


Figure 3-23 Pile Bent Foundation

3.3.2 Prerequisites

3.3.2.1 To Get Started (30% Pier Plans)

The 30% Pier plans show limits of concrete and pile locations. The purpose of this step is to communicate the geometric design intent to the checker. These plans show only limits of concrete and enough annotation to communicate these limits (i.e. dimensions, elevations.)

> ⓘ **It is important to not begin detailing reinforcing steel until the 30% Pier plans and superstructure have been checked by the designer/checker.**

To draw the piers up to this level of completion, the detailer requires the following information:

1) CL Bearing Pier Station
2) Skew Angle
3) Bearing Elevations / Heights (including the preformed leveling pad typically placed under the sole plate of the bearing)
4) Joint Locations (Construction & Contraction)
5) Nose Geometry
6) Approximate Ledge Elevations
7) For Mass Pier

a) Top of Seal Elevation
b) Ledge Elevations
c) Distribution Slab Thickness, Length and Width
d) Top of Shaft length & width
e) Shaft batters

8) For Pile Bent Piers
   a) Pile Cap Length, Width
   b) Bottom of Cap Elevation
   c) Pile Locations
   d) Pile Batter
   e) Pile Embedment
9) For Column-Type Piers
   a) Pier Cap Length & Width
   b) Bottom of Cap Elevation
   c) Column Locations and dimensions
   d) Footing length and width
   e) Top and Bottom of Footing Elevations
   f) Footing Pile Layout

3.3.2.2 To Finish Up (100% Pier Plans)

The following items are required to finish detailing a pier:

1) Checked 30% pier and superstructure plans.
2) Completed and checked reinforcing scheme (designer will communicate reinforcing scheme to detailer via sketches)
3) Pier and pile notes

3.3.3 Detailing

Pier details are primarily CIP Concrete details. The Contractor is the main client to keep in mind when detailing piers.

Solid piers (mass piers) on dry land are supported by footings. These footings may or may not be pile-supported.

Solid piers in the water are supported by distribution slabs on seals.

3.3.4 Typical Sheet Names and Contents

3.3.4.1 Pier or Pier No. X

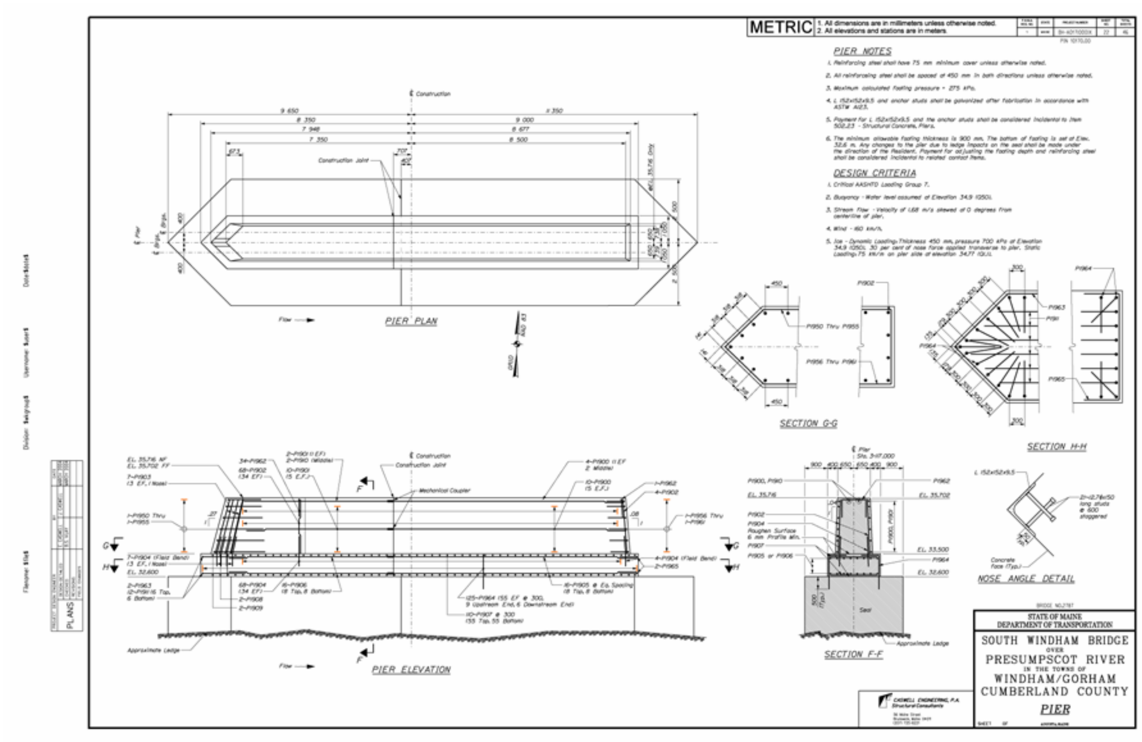


Figure 3-24 Pier Sheet

Will Contain:

1) Pier Plan
2) Pier Elevation
3) Pier Section

May Contain:

1) Pier Notes
2) Pile Notes
3) Other Sections

3.3.4.2 Pier Details

Use only if special details are required, i.e. cathodic protection, rock anchoring, etc.

3.3.5 Standard Notes

3.3.5.1 Pier Notes

1) Reinforcing steel shall have a minimum concrete cover of 3 inches unless otherwise noted.

2) Maximum calculated footing pressure is XX ton per square foot.

3.3.5.2 Design Criteria

1) Critical AASHTO Loading: Group XX.
2) Buoyancy: Water level assumed at Elevation XX.
3) Stream flow: Velocity of XX ft/sec skewed at XX o to longitudinal centerline of pier.
4) Wind: XX mph or XX psf.
5) Ice: Thickness XX inches, pressure 100 psi at Elevation XX, 30% of nose force applied transverse to pier.

3.3.5.3 Seal Cofferdam Notes

1) The seal concrete placement dimensions shown represent the minimum seal size necessary to meet design requirements and are not based on the use of any particular sheet pile section.
2) The horizontal pay limit for seal concrete will be to the dimensions shown on the plans. No additional payment will be made for concrete placed outside of these limits.
3) When sheet piling is used for seal cofferdams, appropriate rolled corners shall be used, and the inside face of the sheet piling shall be at or outside of the seal concrete dimensions shown.
4) The depth of the seal is set for a water elevation of XX. If the water elevation at the time of construction is higher, the depth of the seal shall be adjusted.

(Note for use with seals without piles)

5) The Resident shall approve the method of placing dowels in the seal concrete.

3.3.5.4 Piles

1) Piles marked thus H →, shall be battered XX% in the direction of the arrow.
2) Maximum calculated pile loads: XX kips (including XX kips allowed for negative skin friction).
3) Estimate of piles required:

Abutment Number 1:	XX-HP XX x XX @ XX ft
Abutment Number 2:	XX-HP XX x XX @ XX ft
Pier Number 1:	XX-HP XX x XX @ XX ft
Pier Number 2:	XX-HP XX x XX @ XX ft

4) HP 13 x XX bearing piles may be substituted for HP 14 x XX (HP 12 x XX) bearings piles at the option of the Contractor.

(The following note is used for integral abutments with steel stringers.)

5) Piles shall not be out of position shown by more than 2 inches in any direction.

(The following two notes are used for pile-supported foundations. The Geotechnical Designer will make a recommendation for their use or exclusion. The Structural Designer should determine the appropriate pay item and the Geotechnical Designer determine the number of dynamic tests.)

11) The Contractor shall perform and submit a wave equation analysis for review and acceptance by the Resident. The Contractor shall determine a stopping criteria based on the wave equation analysis. The stopping criteria shall include the blows per inch and the number of 1 inch intervals at which pile installation may be terminated. The cost of performing the wave equation analysis will be considered incidental to pay Item 501.92, Pile Driving Equipment Mobilization.

12) The ultimate capacity shall be the maximum calculated design load times 2.25 per LFD Specifications. The Contractor shall perform XX dynamic load test(s) to confirm the ultimate capacity of the piles. The dynamic test shall be performed on the first production pile driven.

13) All piles shall be equipped with a pile tip in accordance with Standard Specification Section 501.10, Prefabricated Pile Tips.

14) H-pile material shall be ASTM A572M Grade 50.

15) Pile pile material shall be ASTM A252 Grade 2 or 3.

3.3.6 Detail Checklists

3.3.6.1 Pile Bent Pier Plan

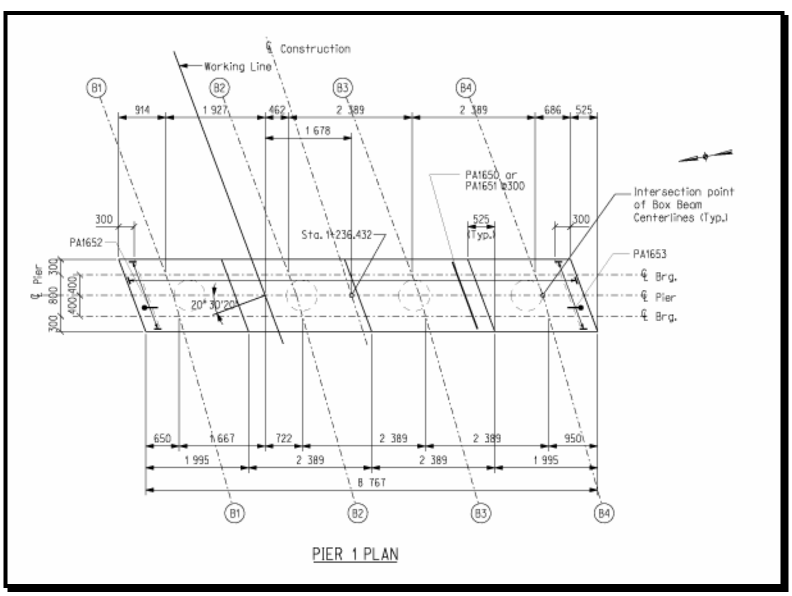


Figure 3-25 Pile Bent Pier Plan

Intro: Top view of pier, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the pier sheet, directly above the Pier Elevation, with the centerlines aligned.

Scale: ¼" (Check sheet up before proceeding. If plan and elevation won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of concrete pier cap
2) Centerline of Construction/Working Line
3) Centerline of girders
4) Centerline of Pier
5) Centerline(s) of Bearing (if other than CL Pier)
6) Outline of steel girder bearings (May be skewed to CL Bearings)
7) Piles (hidden lines)
8) Any steps in top of pier (for different bridge seat elevations)
9) Construction joints (if required for stage construction)
10) May draw reinforcing steel that can't be shown in elevation and section (i.e. horizontal nose reinforcing bars.) Otherwise, no reinforcing steel is shown in this plan.

Dimension:

1) Overall length and width of pier
2) Limits of concrete. Each point/edge should be located from the working point in two directions: parallel and perpendicular to the CL of Pier
3) CL of girder bearings (dimensioned parallel to the CL of Bearings Pier)
4) Bearing steps in top of pier
5) Skew Angle between CL Pier and line normal to CL Construction/Working Line
6) Construction joints

Label:

1) Station at intersection of CL Construction/Working Line and CL Pier
2) Detail Name
3) CL Construction
4) CL Pier
5) CL Brgs. Pier
6) Flow Arrow
7) North Arrow
8) Reinforcing bars
9) Pile batter symbol

10) Construction Joints

3.3.6.2 Pile Bent Pier Elevation

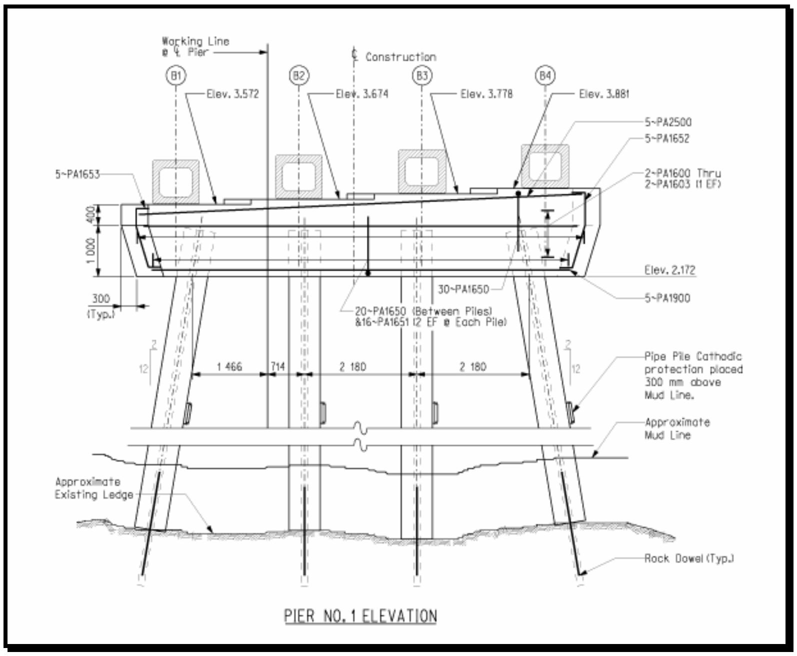


Figure 3-26 Pile Bent Pier Elevation

Intro: Front view of pier, showing the relationship between the bridge seat, pier cap and piles. View is normal to CL Pier.

Sheet up: Belongs directly below the Pier Plan, with the centerlines aligned.

Scale: ¼" (Check sheet up before proceeding. If plan and elevation won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of concrete pier cap
2) Centerline of Construction/Working Line
3) Girders (and bearings for steel girders)
4) Piles
5) Pile embedment into pier cap (hidden lines)
6) Bridge seat(s)
7) Construction joints (if required for stage construction)
8) Pier cap reinforcing steel

Dimension:

1) Sloping top surface of pier nose
2) Chamfer on underside of pier nose

3) CL of girders
4) CL Piles (if you can't show it on the plan)

Label:

1) Detail Name
2) CL Construction/Working Line
3) Bridge seat elevations
4) Pile size
5) Pile batter
6) Reinforcing bars
7) Approximate river streambed surface
8) Approximate existing ledge location
9) Cathodic Protection if required

3.3.6.3 Pile Bent Pier Typical Section

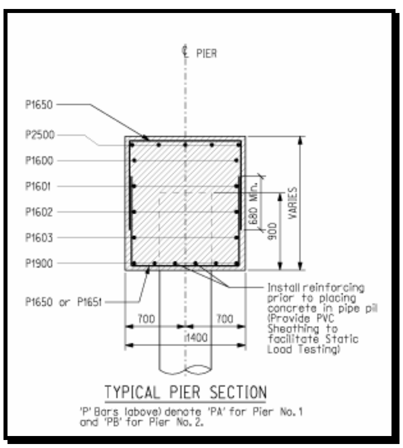


Figure 3-27 Pile Bent Pier Typical Section

Intro: Cross section through pier.

Sheet up: Belongs to the right of the pier plan

Scale: ½" or 3/8" (Typically 2x the plan/elevation scale.)

Draw:

1) Limits of concrete
2) Chamfer on underside of pier cap.
3) Centerline of Pier
4) Centerline of Bearings (if other than CL Pier)
5) Piles

6) Pile embedment into pier cap (hidden lines)
7) Reinforcing bars

Dimension:

1) Pile embedment into pier cap
2) Chamfers
3) Width of pier cap (only if not shown in plan)

Label:

1) Detail Name
2) Reinforcing bars
3) Centerline of Pier
4) Centerline(s) of bearing

3.3.6.4 Pile Bent Pier Typical Pile Section

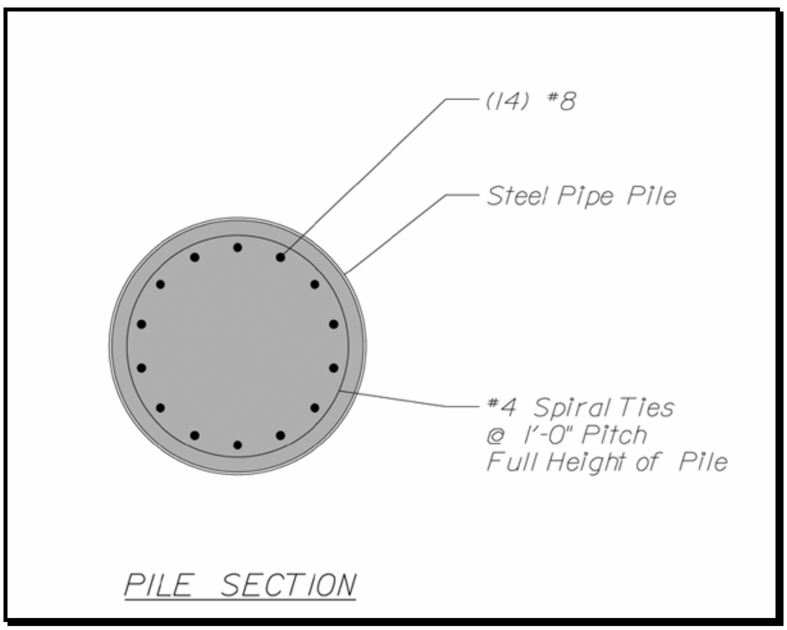


Figure 3-28 Pile Bent Pier Typical Pile Section

Intro: Cross section through concrete-filled pipe pile.

Sheet up: Belongs below pier section or pier elevation

Scale: 1”. Larger scale is acceptable if there is room.

Draw:

1) Steel pipe pile
2) Hatch concrete fill inside pipe pile
3) Spiral tie reinforcing

4) Vertical reinforcing bars

Label:

1) Detail Name “PILE SECTION”
2) Steel pipe pile
3) Size and pitch of spiral tie reinforcing
4) Number and size of vertical reinforcing bars

3.3.6.5 Pile Bent Pier Cathodic Protection – Pipe Piles

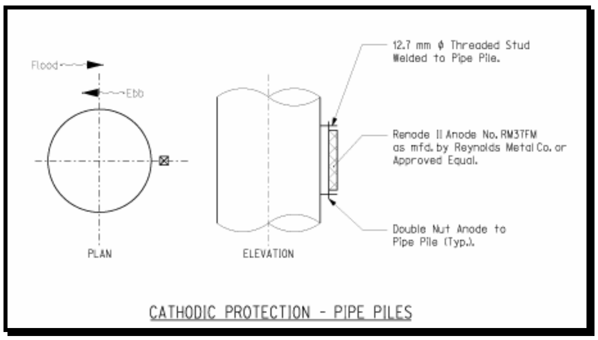


Figure 3-29 Pile Bent Pier Cathodic Protection – Pipe Piles

Intro: Plan and elevation views of anode attached to steel pipe piles for cathodic protection.

Sheet up: Belongs to the right of the pile section

Scale: 3/4”

Draw:

1) Plan View
   a) Pipe pile
   b) Anode
   c) Orthogonal centerlines of pipe pile.
2) Elevation View
   a) Pipe pile (with cut lines)
   b) Anode
   c) Threaded stud connection of anode to pipe pile.

Label:

1) Detail Name (“CATHODIC PROTECTION – PIPE PILES”)
2) Flow arrow (Plan View)
3) Elevation View
   a) Anode elevation

b) Anode type/description/payment

c) Threaded stud welded to pipe pile

d) Double nut anode to threaded stud

3.3.6.6 Column Bent Pier Plan

Intro: Top view of pier, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the pier sheet, directly above the Pier Elevation, with the centerlines aligned.

Scale: ¼" (Check sheet up before proceeding. If plan and elevation won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of concrete pier cap
2) Centerline of Construction/Working Line
3) Centerline of girders
4) Centerline of Pier
5) Centerline(s) of Bearings (if other than CL Pier)
6) Outline of steel girder bearings (May be skewed to CL Bearings Pier)
7) Concrete Columns (hidden lines)
8) Any steps in top of pier (for different bridge seat elevations)
9) Construction joints (if required for stage construction)
10) May draw reinforcing steel that can't be shown in elevation and section (i.e. horizontal nose reinforcing bars.) Otherwise, no reinforcing steel is shown in this plan.

Dimension:

1) Limits of concrete. Each point/edge should be located from the working point in two directions: parallel and perpendicular to the CL of Pier
2) Overall length and width of pier
3) CL of girder bearings (dimensioned parallel to the CL of Bearings Pier)
4) Bearing steps in top of pier
5) Skew Angle between CL Pier and line normal to CL Construction/Working Line
6) Construction joints

Label:

1) Detail Name
2) CL Construction
3) CL Pier

4) CL Brgs. Pier
5) CL Girders
6) Station at intersection of CL Construction/Working Line and CL Pier
7) Reinforcing Steel
8) North
9) Construction joints

3.3.6.7 Column Bent Pier Elevation

Intro: Front view of pier, showing the relationship between the bridge seat(s), pier cap, columns and footings. View is normal to CL Pier.

Sheet up: Belongs directly below the Pier Plan, with the centerlines aligned.

Scale: ¼" (Check sheet up before proceeding. If plan and elevation won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of concrete pier cap
2) Centerline of Construction/Working Line
3) Bridge seat(s)
4) Girders (and bearings for steel girders)
5) Columns (consider using cutlines for tall columns)
6) Column footings
7) Construction joints (if required for stage construction)
8) Pier cap, column and footing reinforcing bars

Dimension:

1) Sloping top surface of pier nose (if required)
2) CL of Columns (only if you can't show it on the plan)

Label:

1) Detail Name
2) CL Construction
3) Bridge seat(s) and top of footing elevations
4) Column size
5) Reinforcing bars
6) Approximate finish grade

3.3.6.8 Column Bent Pier Typical Section

Intro: Cross section through pier cap, column and footing. If the footings are pile supported, show the piles in this section.

Sheet up: Belongs to the right of the pier elevation

Scale: ½" or 3/8" (Typically 2x the plan/elevation scale. Use cutlines through columns to show both cap and footing)

Draw:

1) Limits of pier cap, column and footing
2) Centerline of Pier
3) Centerline(s) of Bearings (if other than CL Pier)
4) Piles, if required
5) Pile embedment into footing (hidden lines)
6) Pier cap, column and footing reinforcing bars

Dimension:

1) Pile embedment into footing
2) Width of Cap, tied to CL Pier (only if not shown in plan)
3) Width of Footing, tied to CL Pier (only if not shown in plan)
4) Chamfers
5) Reinforcing Lap Splice / Embedment Lengths

Label:

1) Detail Name
2) CL Pier
3) CL Brgs. Pier
4) Reinforcing bars
5) Pile size, if required
6) Pile batter, if required

3.3.6.9 Column Bent Pier Column Section

Intro: Cross section through concrete column.

Sheet up: Belongs to the right of the pier plan and above pier section

Scale: 1". Larger scale is acceptable if there is room.

Draw:

1) Limits of concrete column
2) Hatch concrete

3) Spiral tie reinforcing
4) Vertical reinforcing bars

Label:

1) Detail Name ("COLUMN SECTION")
2) Concrete column
3) Size and pitch of spiral tie reinforcing
4) Number and size of vertical reinforcing bars

3.3.6.10 Column Bent Pier Footing Plan

Intro: Top view of column footings, showing the relationship to the working lines. If the footings are pile supported, show the pile layout in this plan.

Sheet up: If the footing plan does not fit on pier sheet under the pier elevation, add a Pier Footing Sheet and show the plan in the upper left of the sheet.

Scale: 3/16". Larger scale is acceptable if there is room.

Draw:

1) Limits of concrete footings
2) Centerline of Construction/Working Line
3) Centerline of Pier
4) Centerline of Columns
5) Footing reinforcing bars
6) Piles, if required
7) Centerlines of piles, if required

Dimension:

1) Limits of concrete footings. Each point/edge should be located from the working point in two directions: parallel and perpendicular to the CL of Pier
2) CL of piles or indicate pile spacing
3) Skew Angle between CL Pier and line normal to CL Construction/Working Line
4) Reinforcing Steel (location and laps)

Label:

1) Detail Name
2) CL Construction/Working Line
3) CL Pier
4) CL Columns
5) CL Piles

6) Station at intersection of CL Construction/Working Line and CL Pier
7) Reinforcing bars
8) Pile size
9) Pile batter symbol
10) North Arrow

3.3.6.11 Solid Pier Plan

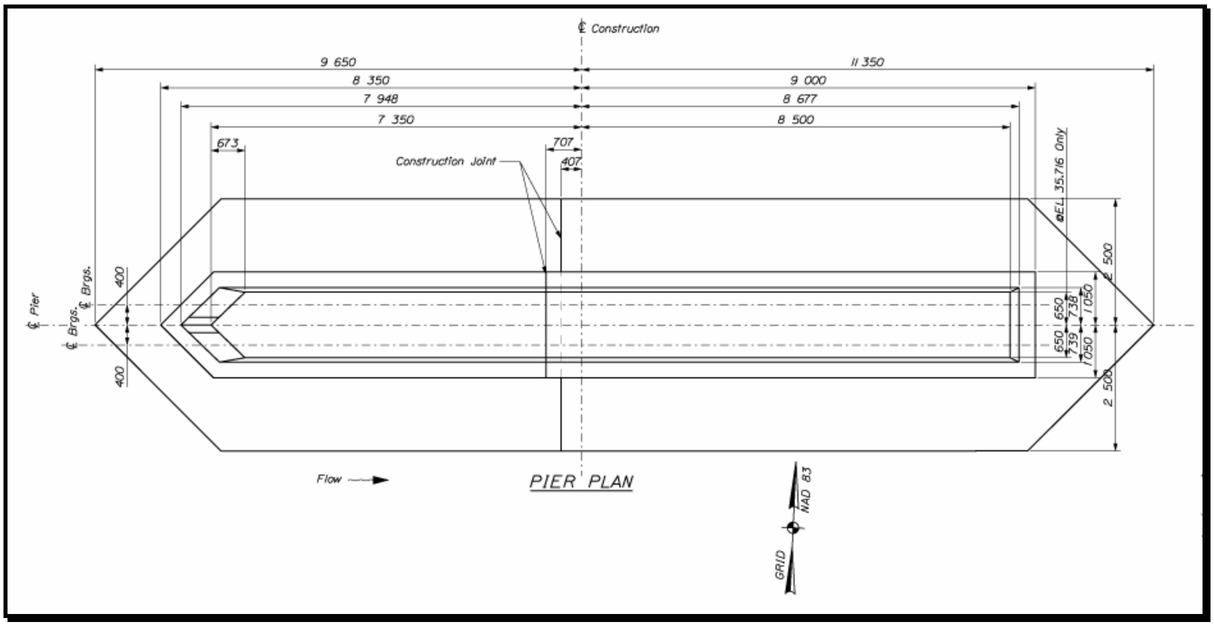


Figure 3-30 Solid Pier Plan

Intro: Top view of pier, showing the relationship to the working lines. Plan should include pier shaft and footing.

Sheet up: Belongs in the upper left of the pier sheet, directly above the Pier Elevation, with the centerlines aligned.

Scale: ¼" (Check sheet up before proceeding. If plan and elevation won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of concrete
2) Centerline of Construction/Working Line
3) Centerline of girders
4) Centerline of Pier
5) Centerline(s) of Bearings (if other than CL Pier)
6) Outline of steel girder bearings (May be skewed to CL Bearings Pier)

7) Any steps in top of pier (for different bridge seat elevations)
8) Construction joints (if required for stage construction)
9) Nose Angle (steel protection for shaft nose)

Dimension:

1) Limits of concrete. Each point/edge should be located from the working point in two directions: parallel and perpendicular to the CL of Pier
2) Overall width of footing and top and bottom of pier shaft
3) CL of girder bearings (dimensioned parallel to the CL of Bearings Pier)
4) Bearing steps in top of pier
5) Skew Angle between CL Pier and line normal to CL Construction/Working Line
6) Construction joints

Label:

1) Detail Name
2) CL Construction / Working Line
3) CL Pier
4) CL Brgs. Pier
5) Station at intersection of CL Construction/Working Line and CL Pier
6) Flow Arrow
7) North Arrow
8) Construction joints

3.3.6.12 Solid Pier Elevation

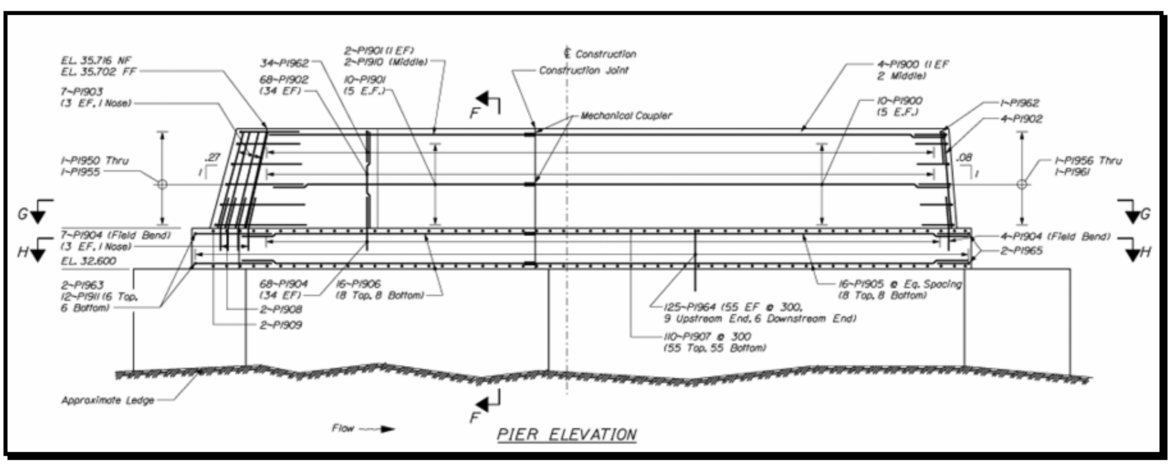


Figure 3-31 Solid Pier Elevation

Intro: Front view of pier, showing the relationship between the bridge seat(s), shaft and footing View is normal to CL Pier.

Sheet up: Belongs directly below the Pier Plan, with the centerlines aligned.

Scale: ¼" (Check sheet up before proceeding. If plan and elevation won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of concrete pier shaft and footing
2) Centerline of Construction/Working Line
3) Bridge seat(s)
4) Construction joints (if required for stage construction)
5) Reinforcing steel (if footing is supported on piles, omit footing bars here and show on Footing and Pile Layout Plan)

Dimension:

1) Sloping top surface of pier nose (if required)
2) Reinforcing laps/embedments

Label:

1) Bridge seat(s) and top of footing elevations
2) Pier Batter
3) Reinforcing bars
4) Approximate existing ledge location

3.3.6.13 Solid Pier Typical Section

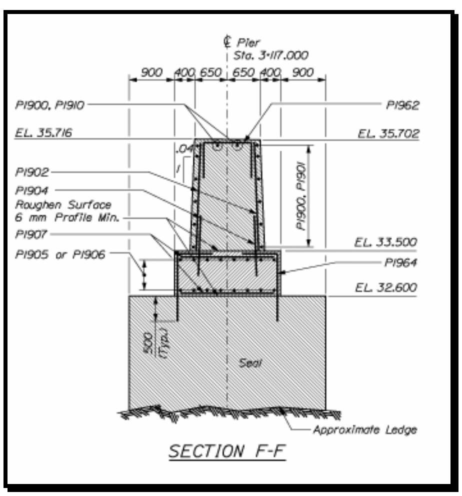


Figure 3-32 Solid Pier Section

Intro: Cross section through pier shaft and footing.

Sheet up: Belongs to the right of the Pier Elevation with bridge seat(s) aligned.

Scale: Same as Pier Elevation, typically ¼" or 3/8"

Draw:

1) Limits of concrete
2) Centerline of Pier
3) Centerline(s) of Bearings (if other than CL Pier)
4) Piles, if required
5) Pile embedment into footing (hidden lines)
6) Reinforcing bars.

Dimension:

1) Width of shaft and footing from CL Pier
2) Pile embedment into footing

Label:

1) Detail Name
2) Reinforcing bars
3) Pier shaft batter
4) Pile size, if required
5) Pile batter, if required

3.3.6.14 Solid Pier Footing and Pile Layout Plan

Intro: Top view of footing and piles, showing the relationship to the working lines. This plan is required only when footing is pile supported.

Sheet up: Belongs in the upper left of the Pier Footing Sheet.

Scale: 1/4” or 3/8”. Use same scale as Pier Plan

Draw:

1) Limits of concrete footing
2) Centerline of Construction/Working Line
3) Centerline of Pier
4) Piles
5) Centerlines of piles
6) Construction joints (if required for stage construction)
7) Footing reinforcing bars

Dimension:

1) Limits of concrete. Each point/edge should be located from the working point in two directions: parallel and perpendicular to the CL of Pier
2) Overall length and width of footing

3) CL of piles or indicate pile spacing
4) Skew Angle between CL Pier and line normal to CL Construction/Working Line
5) Construction joints

Label:

1) Detail Name
2) Station at intersection of CL Construction/Working Line and CL Pier
3) Pile size
4) Reinforcing bars
5) North Arrow
6) Flow Arrow at water crossings.
7) Construction joints
8) Pile batter symbol

3.3.6.15 Solid Pier Nose Angle Detail

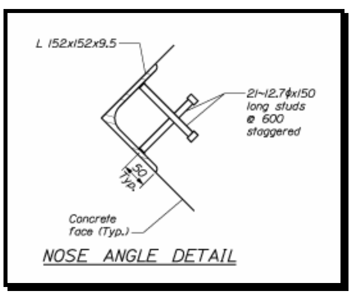


Figure 3-33 Solid Pier Nose Angle Detail

Intro: Cross section through structural steel nose angle

Sheet up: Belongs below to the right of the Pier Section

Scale: 1½".

Draw:

1) Structural steel angle
2) Shear studs
3) Face of concrete shaft

Dimension:

1) Location of shear studs

Label:

1) Detail Name
2) Structural steel angle size

3) Size, spacing and total number of shear studs
4) Face of concrete shaft

3.4 Cast-in-place Concrete Retaining Walls

3.4.1 Introduction

Cast-in-place Concrete Retaining Walls include:

1) Cantilever walls
2) Gravity walls

3.4.2 Prerequisites

3.4.2.1 To Get Started (30 Retaining Wall Plans%)

The following information should be gathered before you begin detailing:

1) Wall length and location
2) Wall thickness(es)
3) Wall batter (where applicable)
4) Footing Toe and Heel width
5) Top of wall elevation
6) Top and Bottom of Footing Elevations (Sometimes Ledge or Seal Elevations)
7) Pile Locations
8) Pile Batter
9) Joint Locations (Construction & Contraction)
10) Backfill requirements
11) Potential Utility Impacts
12) Potential Railing/Roadway impacts

3.4.2.2 To Finish Up (100% Retaining Wall Plans)

1) Checked 30% retaining wall plans
2) Completed and checked reinforcing scheme (designer will communicate reinforcing scheme to detailer via sketches)
3) Retaining wall and pile notes
4) Pay Limit information (structural earth excavation, granular borrow, etc.)

3.4.3 Detailing

CIP Retaining Wall details are primarily CIP Concrete details. The Contractor is the main client to keep in mind when detailing CIP Retaining Walls.

Walls are dimensioned to their control points. Control points are always on the face of the wall at the top of both ends of the wall.

3.4.4 Typical Sheet Names and Contents

3.4.4.1 Retaining Wall

Will Contain:

1) Retaining Wall Plan
2) Retaining Wall Elevation
3) Retaining Wall Section
4) Retaining Wall Notes

May Contain:

1) Footing and Pile Layout Plan
2) Pile Notes
3) Plans and Elevations for additional wall or walls

3.4.5 Checklists

3.4.5.1 Retaining Wall Footing and Pile Layout Plan

Intro: Top view of footing and piles. This plan is required only when footing is pile supported.

Sheet up: Belongs in the upper left of the Retaining Wall Sheet.

Scale: 1/4" or 3/8". Use same scale as Retaining Wall Plan

Draw:

1) Limits of concrete footing
2) Steps in footing
3) Face of retaining wall (control line)
4) Piles
5) Centerlines of piles
6) Construction joints (if required for stage construction)
7) Footing reinforcing bars

Dimension:

1) Limits of concrete (tied to control line)
2) Overall length and width of footing
3) Steps in footing
4) CL of piles or indicate pile spacing

5) Construction joints

Label:

1) Detail Name
2) Station and Offset of Control Points
3) Pile size
4) Reinforcing bars
5) North Arrow
6) Construction joints
7) Pile batter symbol

3.4.5.2 Retaining Wall Plan

Intro: Top view of retaining wall. Plan should include both wall and footing.

Sheet up: Belongs in the upper left of the retaining wall sheet, directly above the Retaining Wall Elevation, with the control points aligned.

Scale: ¼” (Check sheet up before proceeding. If plan and elevation won’t fit above and below at ¼”, try 3/16” scale.)

Draw:

1) Limits of concrete
2) Any steps in top of wall
3) Construction joints

Dimension:

1) Limits of concrete.
2) Overall width of footing and top and bottom of wall
3) Steps in wall and/or footing
4) Construction joints

Label:

1) Detail Name
2) Station and Offset of Control Points
3) North Arrow
4) Construction joints

3.4.5.3 Retaining Wall Elevation

Intro: Front view of wall, showing the relationship between the wall and footing View is normal to face of wall.

Sheet up: Belongs directly below the Retaining Wall Plan, with the control points aligned.

Scale: ¼" (Check sheet up before proceeding. If plan and elevation won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of concrete wall and footing
2) Construction joints
3) Reinforcing steel (if footing is supported on piles, omit footing bars here and show on Footing and Pile Layout Plan)
4) Proposed grade (at face of wall)
5) Existing grade (at face of wall)
6) Approximate Ledge

Dimension:

1) Reinforcing laps/embedments

Label:

1) Top of wall elevation(s)
2) Top of footing elevation(s)
3) Reinforcing bars
4) Approximate existing ledge
5) Approximate finished grade
6) Approximate existing grade

3.4.5.4 Retaining Wall Section

Intro: Sections must be cut on the Retaining Wall plan and elevation. They are used to show wall thickness, reinforcing steel, and to clarify concrete and earthwork limits.

- ♫ Sections should always be cut from the right side of the project looking left, such that the left of the section is downstation, or looking upstation, such that project left is on the left.

Sheet-up: Belongs on the Retaining Wall Sheet, to the right of the plan and elevation.

Scale: ½"

Draw:

1) Concrete limits
2) Horizontal construction joints (show shear keys)
3) Piles
4) Ledge line
5) Reinforcing Steel

6) French Drains
7) Weepers
8) Backfill limits (pattern backfill areas)
9) Riprap (pattern limits)
10) If the retaining walls are close to the road, you may need to show guard rail mounted on the walls.

Dimension:

1) Thickness of the wall
2) Reinforcing dowel embedments/projections and lap splices
3) Non-typical reinforcing cover (i.e. at bottom of footing)
4) Pile Embedment into footing/breastwall
5) Earthwork limits
6) Riprap thickness

Label:

1) Detail Name
2) Non-standard Chamfer sizes
3) Ledge should be labeled "Approximate Ledge"
4) Rise/Run of all slopes (battered faces of concrete, piles, finished grade of riprap, limits of backfill, etc.)
5) Reinforcing Steel
6) Weepers
7) Piles (generic label, i.e. "H Pile", w/o specific designation)
8) Backfill material (French Drain, borrow, etc.)
9) Pay Limits (Structural earth excavation, Granular borrow, Gravel borrow, etc.)

3.5 Pre-Engineered Retaining Walls

3.5.1 Introduction

Pre-Engineered Retaining walls include the following:

1) Prefabricated proprietary Walls
   a. Proprietary Retaining Walls
   b. Prefabricated Bin Type Retaining Walls
   c. Modular Block Walls
   d. MSE Walls
2) Anchored Walls
3) Gabions

3.5.2 Prerequisites

3.5.2.1 To Get Started

1) Exact length and location of the wall
2) Elevations of top and bottom of wall

3.5.2.2 To Finish Up

1) Wall Notes
2) Proposed and Finished grade relationship to face of wall

3.5.3 Detailing

Pre-Engineered Retaining Wall details are primarily performance-based details. The Designer and Fabricator of the wall are the main clients to keep in mind when detailing Pre-Engineered Retaining Walls.

Even though the exact depth of the wall system isn't normally shown to scale, it should be checked for conflicts with utilities or stage construction activities.

Walls are dimensioned to their control points. Control points are always on the face of the wall at the top of both ends of the wall.

3.5.4 Typical Sheet Names and Contents

3.5.4.1 Retaining Wall

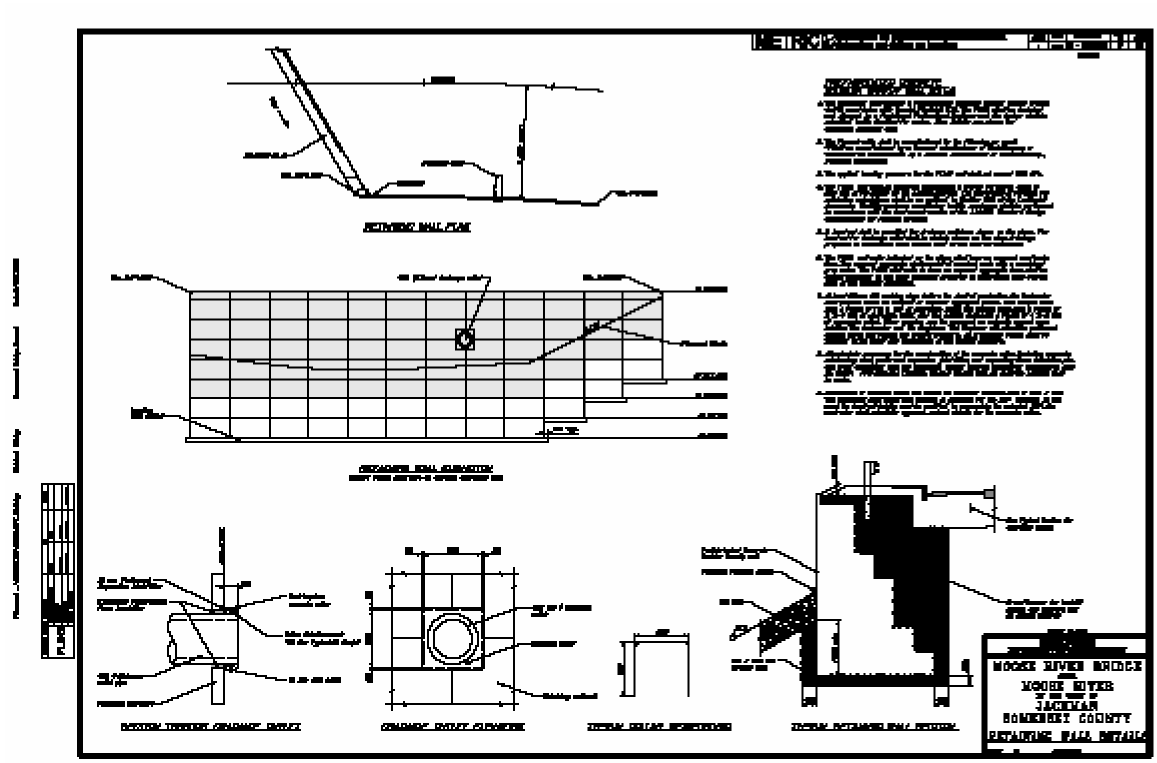


Figure 3-34 Retaining Wall Sheet

Will Contain:

1) Wall Plan
2) Wall Elevation
3) Wall Section
4) Wall Notes

May Contain:

1) Plans and Elevations for additional wall or walls
2) Utility/Other Details

3.5.5 Standard Notes

3.5.5.1 Prefabricated Concrete Modular Gravity Wall Notes

1) The Contractor shall provide a Prefabricated Concrete Modular Gravity (PCMG) wall in accordance with Special Provision 635. The PCMG shall be designed and stamped by a Registered Professional Engineer and the design shall be submitted to the Resident for review. Plan Details are shown for estimating purposes only.

2) The precast units shall be manufactured by the following, or equal: "T-Wall" as manufactured by Superior Concrete Co., Inc. of Auburn, Maine, or DoubleWal as manufactured by a licensed manufacturer of DoubleWal Corp., Plainville, Connecticut.
3) The applied bearing pressure for the PCMG wall shall not exceed XX tsf.

(The following note is used when the bridge passes over salt water.)

4) The PCMG wall shall consist of LP concrete and epoxy-coated rebar.

(The following note is used when cofferdams are required.)

5) Cofferdams for the PCMG wall installation shall be included with Pay Item 511.07 – Cofferdam.

3.5.6 Checklists

3.5.6.1 Wall Plan

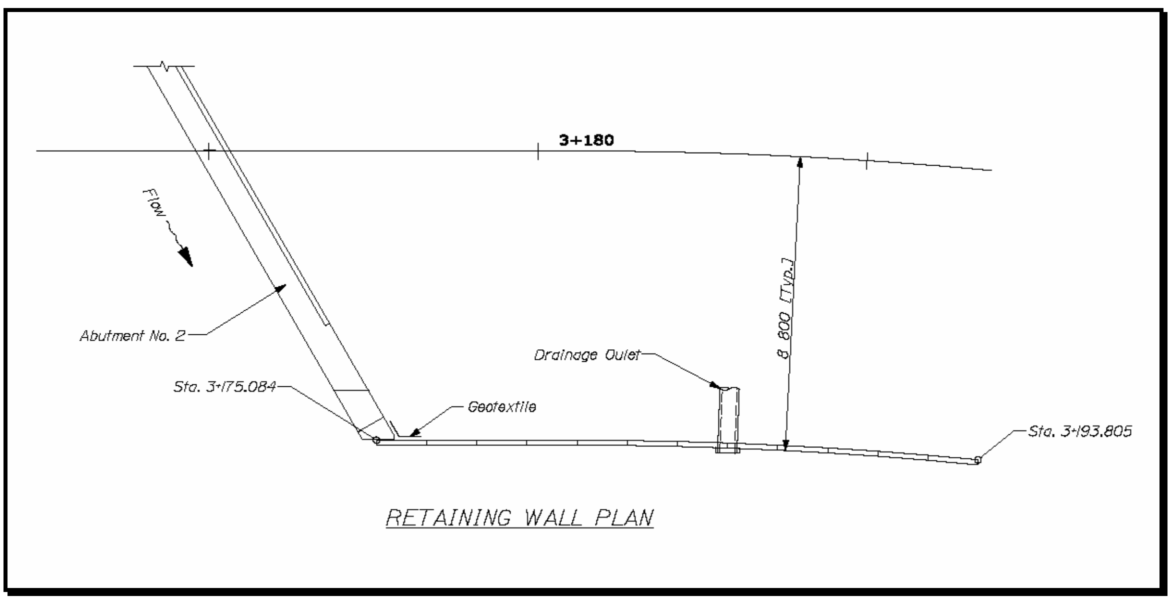


Figure 3-35 Wall Plan

Intro: The wall plan shows the length and location of the retaining wall. All dimensions are given relative to control points, which are located at the top face of the wall.

Sheet up: Belongs on the Retaining Walls sheet, at the top left.

Scale: ¼"

Draw:

1) Wall – the thickness is diagrammatic.

Dimension:

1) Wall length

Label:

1) Detail Name
2) Station and offset of control points.

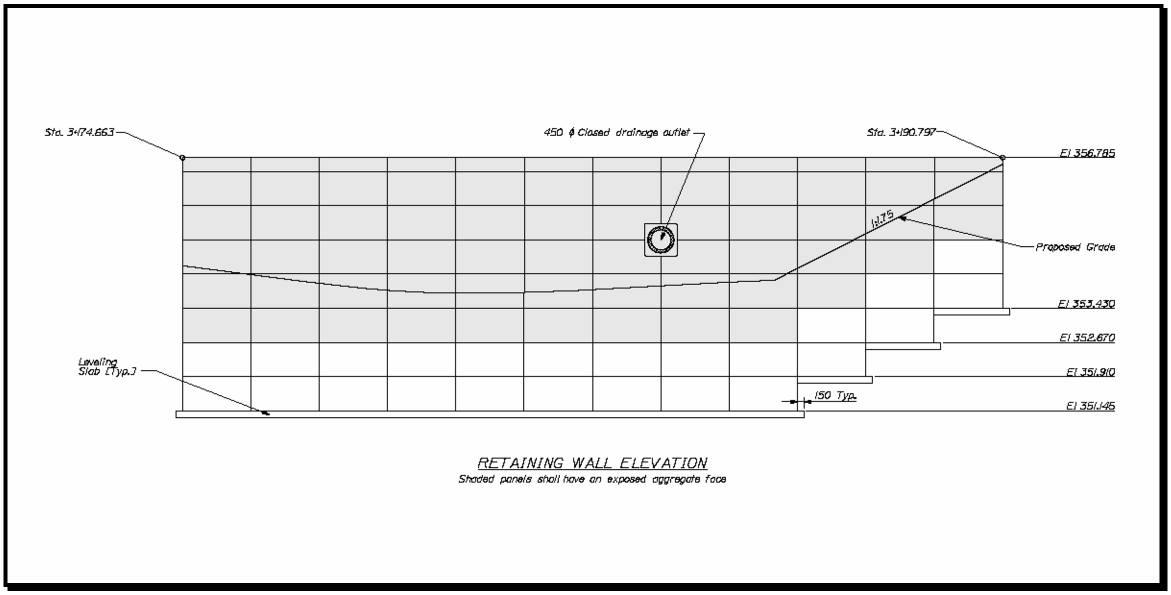


Figure 3-36 Wall Elevation

3.5.6.2 Wall Elevation

Intro: The wall elevation shows the height of the wall, top and bottom elevations, and proposed and existing grade.

Sheet up: Belongs on the Retaining Walls sheet, directly below the plan with control points aligned.

Scale: ¼" or same as plan.

Draw:

1) Top of wall
2) Bottom of wall
3) Proposed Grade
4) Existing Grade

Label:

1) Detail name
2) Top of wall elevation
3) Bottom of wall elevation
4) Existing Grade
5) Proposed Grade

3.5.6.3 Wall Section

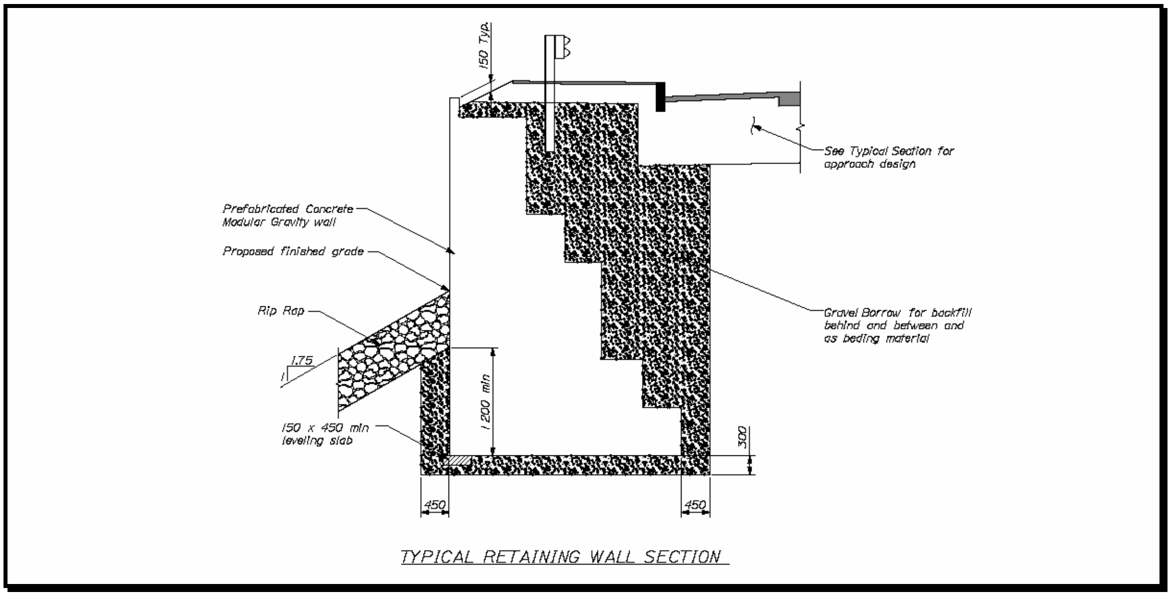


Figure 3-36 Wall Section

Intro: The wall section shows the relationship of the wall to the proposed ground, backfill, and bedding material.

Sheet up: Belongs on the Retaining Walls sheet.

Scale: ½”

Draw:

1) Wall (thickness diagrammatic)
2) Proposed grade and roadway elements above wall
3) Proposed grade below wall
4) Bedding material
5) Approximate backfill limits and material
6) Show any utilities in the vicinity of the wall

Dimension:

1) Depth of bottom of wall below finished grade in front of wall
2) Reveal at top of wall (control point to finished grade at back of wall)
3) Width of bedding material in front of wall
4) Width of backfill material behind back of wall
5) Depth of bedding material below wall

Label:

1) Detail Name

2) Control Point
3) Backfill Material
4) Bedding Material
5) Finished grade slopes, above and below wall
6) Utilities

CHAPTER 4 SUPERSTRUCTURES

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4.2 Steel Girders

4.2.1 Introduction

This section deals with the detailing of a structure consisting of a cast-in-place concrete deck on steel stringers.

4.2.2 Prerequisites

4.2.2.1 To Get Started (30% Superstructure Plans)

The 30% Superstructure plans show beam sizes, beam layout, and superstructure concrete limits.

> ⓘ **It is important to not begin detailing reinforcing steel until the 30% superstructure plans have been checked by the designer/checker.**

To draw the superstructure up to this level of completion, the detailer requires the following information:

1) CL Bearings Abutment and Pier Stations
2) Substructure Skew Angle
3) Span Lengths (Pay attention to relationship of CL Construction and Working Line of a curved bridge. Refer to Chapter 2 for guidance.)
4) Joint Locations (Construction & Contraction)
5) Roadway width and cross-slope
6) Curb/Sidewalk widths
7) Wearing Surface Type and Thickness
8) Slab Thickness
9) Rail Type
10) Rail Post Locations (can be developed by detailer from standard detail information.)
11) Girder Spacing & Slab Overhang
12) Beam Type/Size
13) Beam Blocking Height
14) Diaphragm Type and Spacing
15) Bearing Types
16) Field Splice Locations

4.2.2.2 To Finish Up (100% Superstructure Plans)

The following items are required to finish detailing a superstructure:

1) Completed and checked 30% superstructure plans.
2) Completed and checked reinforcing scheme (designer will communicate reinforcing scheme to detailer via sketches)
3) Superstructure and Structural Steel Notes
4) Bridge Drain Type & Locations
5) Beam Overhangs
6) Stiffener Sizes and Locations
7) Weld Sizes and Types
8) Beam Splice Details
9) Shear Stud Layout
10) Sketch of Beam Stress-Type Diagram
11) Lateral Bracing size and location (where req'd)
12) Sketch of Camber Diagram and Table
13) Bottom of Slab Grades
14) Dead Load Deflections
15) Sketch of Blocking Point Layout Diagram
16) Utility Size, Type, and Location
17) For Steel Bearings, Expansion Pedestal Bearing Chart

4.2.3 Detailing

Steel Girder Superstructures require explicit rather than performance-based detailing. Some details are developed primarily for the Fabricator (camber diagram, stress-type diagram) and some are developed primarily for the Contractor (superstructure plan, transverse section, bottom of slab grades.) Some details are required equally by both Fabricator and Contractor (structural steel framing plan, beam elevation.)

4.2.4 Typical Sheet Names and Contents

4.2.4.1 STRUCTURAL STEEL

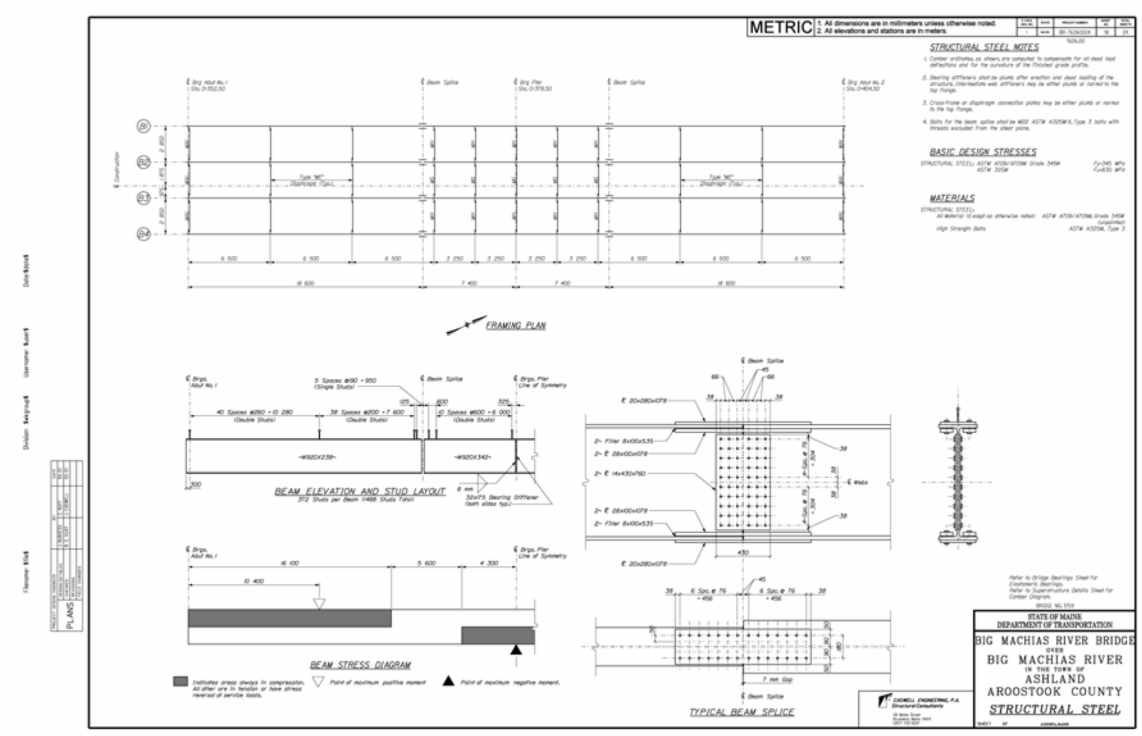

Figure 4-1 Steel Girder Structural Steel Sheet

Will Contain:

1) Framing Plan
2) Girder Elevation and Stud Layout
3) Structural Steel Notes
4) Basic Design Stresses (Note)
5) Materials (Note)

May Contain:

1) Camber Diagram
2) Beam Stress Diagram
3) Splice Details

4.2.4.2 SUPERSTRUCTURE

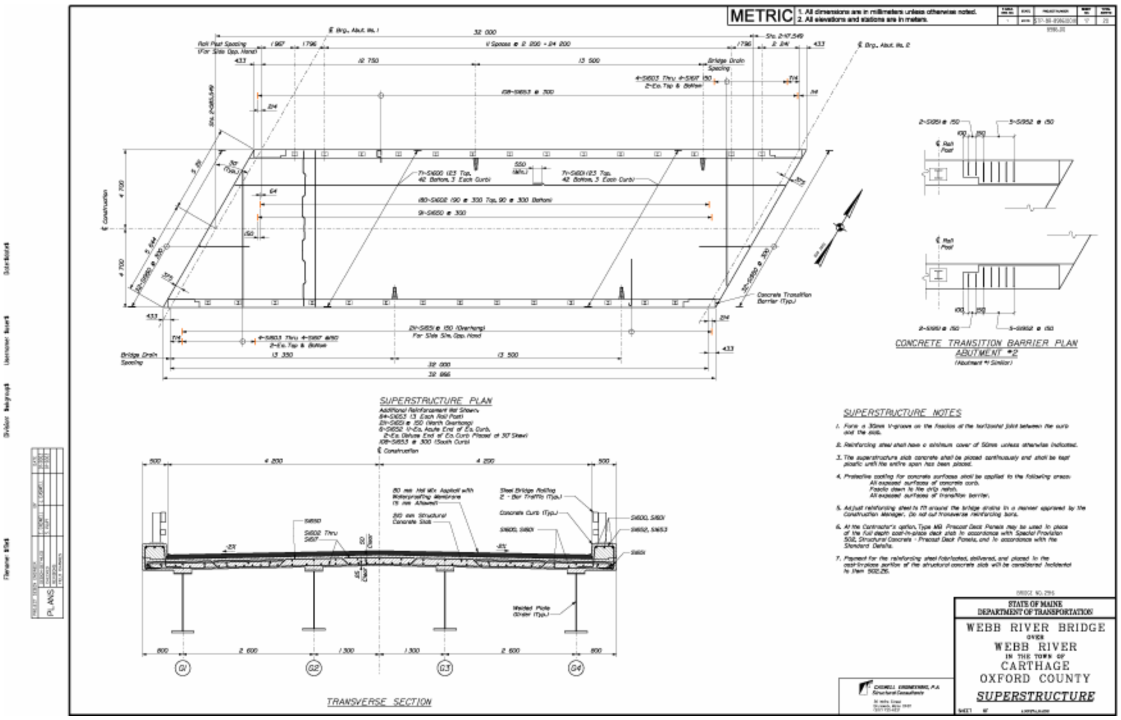

Figure 4-2 Steel Girder Superstructure Sheet

Will Contain:

1) Superstructure Plan
2) Transverse Section
3) Superstructure Notes

May Contain:

1) Slab Haunch and Blocking Detail
2) Barrier Plan End Details (to show reinforcing in the ends of concrete barriers)
3) End of Slab Sections

4.2.4.3 SUPERSTRUCTURE DETAILS

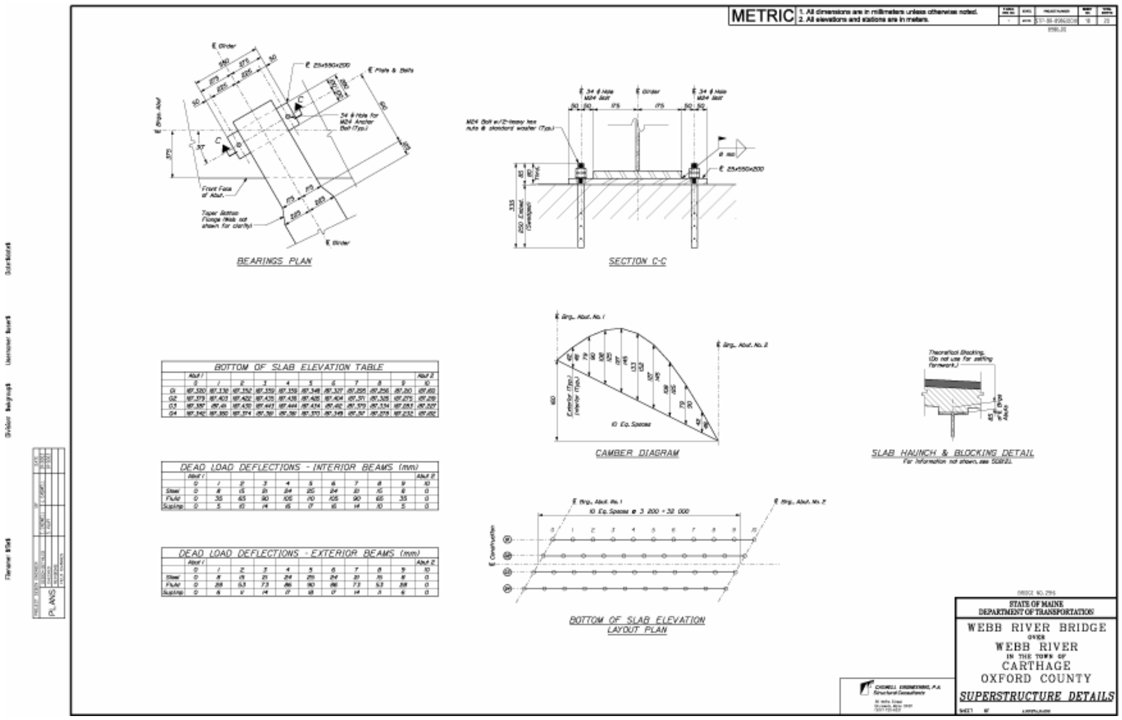

Figure 4-3 Steel Girder Superstructure Details

Will Contain:

1) Bottom of Slab Elevation Table
2) Dead Load Deflection Tables
3) Bottom of Slab Elevation Layout Plan

May Contain:

1) Camber Diagram & Camber Table
2) End of Slab Sections
3) Slab Haunch and Blocking Detail
4) Bearing Details
5) Rail Details
6) Fascia Offsets (curved bridges only)

4.2.4.4 BRIDGE BEARINGS

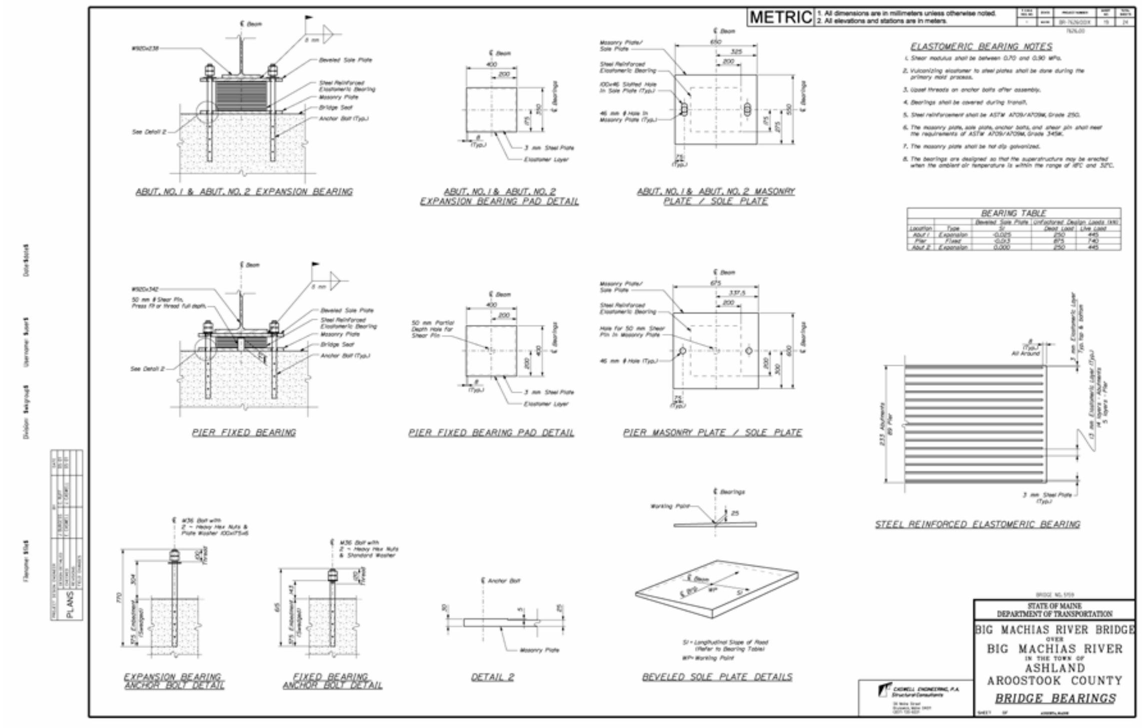

Figure 4-4 Steel Girder Bridge Bearings Sheet

Will Contain:

1) Bearing Notes
2) Bearing Details/Sections

May Contain:

1) Bearing Table
2) Plate Details/Sections

4.2.5 Standard Notes

4.2.5.1 Superstructure Notes

1) Form a 1 inch V-groove on the fascias at the horizontal joint between the curb and slab.
2) Reinforcing steel shall have a minimum cover of 2 inches unless otherwise noted or shown.
3) Adjust reinforcing steel to fit around the bridge drains in a manner approved by the Resident. Do not cut transverse reinforcing bars.
4) The Contractor shall install Transition Barrier vertical closed stirrups, as shown in the Standard Details Section 526 prior to the placement of the curb or sidewalk concrete.

(The following note is used for simple span structures.)

5) The superstructure slab concrete for each span shall be placed in one continuous operation and shall be kept plastic until the entire placement has been made.

(The following note is used for multiple span continuous structures with less than 250 yd 3 of deck concrete.)

6) The superstructure slab concrete shall be placed in one continuous operation and the concrete shall be kept plastic one complete span behind the span being placed.

(The following note is used for multiple span continuous structures with more than 250 yd 3 of deck concrete.)

7) Unless the superstructure slab concrete is placed in one continuous operation, the initial placement shall start at a simply supported end of the deck slab and shall terminate at the completion of a positive moment section. Successive placements shall proceed from the end of the previous placement, terminate at the completion of a positive moment section, and include two or more spans. Concrete in a placement shall be kept plastic one complete span behind the span being placed. A minimum of 5 days shall elapse between successive partial placements. The Resident shall approve the placement sequence of the superstructure slab concrete.

(The following note is used with staged construction of CIP structural slabs.)

8) The formwork and its supports, over the full width of the structural slab, shall remain in place until a minimum of 48 hours has elapsed after placement of the final section of the slab. After this period, removal of formwork for sections may then proceed and shall meet the requirements for form removal in Standard Specifications Section 502, Structural Concrete.

9) Mortar for bedding and for joints in the granite curb shall contain an approved non-shrink additive.

(The following notes are used when Precast Deck Panels are allowed)

10) At the Contractor's option, Precast Deck Panels may be used in place of the full depth cast-in-place deck slab, in accordance with special provisions Section 502, Structural Concrete – Precast Deck Panels, and in accordance with the Standard Details.

11) Payment for reinforcing steel fabricated, delivered and placed in the cast-in-place portion of the structural concrete slab will be considered incidental to the appropriate Section 502 pay item.

4.2.5.2 Structural Steel Notes

1) Camber ordinates as shown are computed to compensate for all dead load deflections and for the curvature of the finished grade profile.

2) No transverse butt-weld splices will be allowed in the flange plates or web plates within 10 feet or 10% of the span length (whichever is greater) from the points of maximum negative moment or maximum positive moment. Butt-weld splices in flanges shall be not less than 3 feet from transverse butt-welds in the web plates and no transverse web or flange butt-welds shall be located within 3 feet of other transverse welds (e.g. connection plates to web welds) on either flange or web. No transverse butt-weld splices will be allowed in areas of stress reversal.

3) Sections of flange plates or web plates between transverse shop splices or between a transverse shop splice and a field splice shall be not less than XX feet in length unless otherwise shown on the plans.
4) One longitudinal butt weld splice will be allowed in the web of the haunched sections of the girders. Feather edges between the longitudinal welds and the bottom flanges will not be allowed.
5) Bearing stiffeners shall be plumb after erection and dead loading of the structure. Intermediate web stiffeners may be either plumb or normal to the top flange.
6) Cross-frame or diaphragm connection plates may be either plumb or normal to the top flange.

(The following note is used only with designs using A709, Grade 50 or painted Grade 50W.)

7) Filler plates may be steel conforming to the requirements of A709, Grade 36.
8) The dimensions and elevations omitted from the Bottom of Slab Elevations table, the Camber Diagram, and the Stress Diagram will be provided to the Contractor for the structural steel option that has been selected.
9) At locations marked with an asterisk (*), the designated diaphragms shall be changed to a Type A (C) (D) diaphragm as required to accommodate the Contractor's deck placement sequence. No extra compensation will be allowed for any diaphragms so substituted, and any additional costs will be considered incidental to the Contract items.
10) Theoretical blocking used for design of the structure is XX inch(es) at the centerline of bearing at the abutments and piers. Refer to *Standard Details* 502 (02) for blocking details.

(The following note is used when web depth is 6 feet or greater.)

11) Handhold bars shall be installed in accordance with the Plans and Standard Detail 504 (21-24).

(The following note is used when a single span rolled beam with 3" or more camber is used.)

12) The Contractor may substitute welded plate girders in place of the rolled beams shown on the plans, as approved by the Resident. The fabricator shall determine the plate thicknesses based upon the depth and moment of inertia of the rolled section.

4.2.5.3 Elastomeric Bearings Notes

1) The shear modulus shall be between 80 and 175 psi.
2) Vulcanizing of the elastomer to the steel plates shall be done during the primary mold process.

(The following two notes are used when anchor rods are required.)

3) Upset the threads on the anchor rods after assembly of the bearing.
4) Bearings shall be covered during transit.
5) The masonry plate, sole plate, and shear pin shall meet the requirements of ASTM A709/A709M, Grade 50 or 50W. Anchor rods shall meet the requirements of ASTM F 1554, Grade 105 and shall be swedged on the embedded portion of the rod.

6) The bearings are designed so that the superstructure may be erected when the ambient air temperature is within the range of 65°F and 90°F. If the ambient air temperature is outside of this range, the bearings shall be reset as directed by the Resident.
7) The masonry plate shall be hot dip galvanized in accordance with Section 506. Sole plates for steel superstructures shall be treated in the same manner as the structural steel. Anchor rods, washers, nuts, and shear pins shall be galvanized to ASTM A 153 or ASTM B 695, Class 50, Type 1.
8) All bearings shall be marked prior to shipping. The marks shall include the bearing location on the bridge, and a direction arrow which points up-station. All marks shall be permanent and shall be visible after the bearing is installed.

(Use the following note when bearings are to be welded to steel girders)

9) All necessary precautions shall be taken to protect bearing components from field weld flash and splatter. Heat from welding operations shall be controlled such that steel adjacent to the elsatomer does not exceed 200 °F. The temperature shall be verified by the use of temperature indicating crayons or other suitable means.

4.2.5.4 HLMR Bearings Notes

1) Refer to the Special Provisions for design, materials, fabrication, and general construction requirements.
2) The actual dimension "H" shall be the responsibility of the Contractor. Dimensions and sizes of plates not shown are dependent on design loads, bearing type, capacity, and the manufacturer of the bearings. The shop drawings, prepared by the manufacturer, shall provide all pertinent bearing information. The final bridge seat elevations shall be determined by the Contractor and submitted with the shop drawings for approval prior to construction of the substructure units.
3) Masonry plates shall be placed on 1/4" thick preformed pads in accordance with the specifications.

(Edit the following note to "Grade 55" if a higher strength anchor rod is required)

4) All steel, except anchor rods, shall be AASHTO M270, Grade 70W.
5) Anchor rods shall meet the requirements or ASTM F1554, Grade XX, and swedged on the embedded portion of the rod.
6) Anchor bolt spacing shall be coordinated with the bearing manufacturer.
7) Bearing installation shall be in strict conformance with the Special Provisions and the manufacturer's recommendations.
8) The abbreviation "PTFE" indicates polytetraflouroethylene.
9) The design temperature range shall be 150 °F (-30 °F to 120 °F)
10) At abutment bearings only, all steel located below the PTFE sliding surface shall be coated in accordance with Special Provision, Section 506, Protective Coating-Steel (Thermal Spray

Coating). All remaining steel at abutment bearings shall be coated in accordance with Special Provision, Section 506, Protective Coating-Steel (Zinc Rich System).

11) All bearings shall be marked prior to shipping. The marks shall include the bearing location on the bridge, and a direction arrow that points up-station. All marks shall be permanent and shall be visible after the bearing is installed.

(The following note is used if applicable.)

12) Bearings need not be designed with hold-downs.

4.2.6 Checklists

4.2.6.1 Superstructure Plan

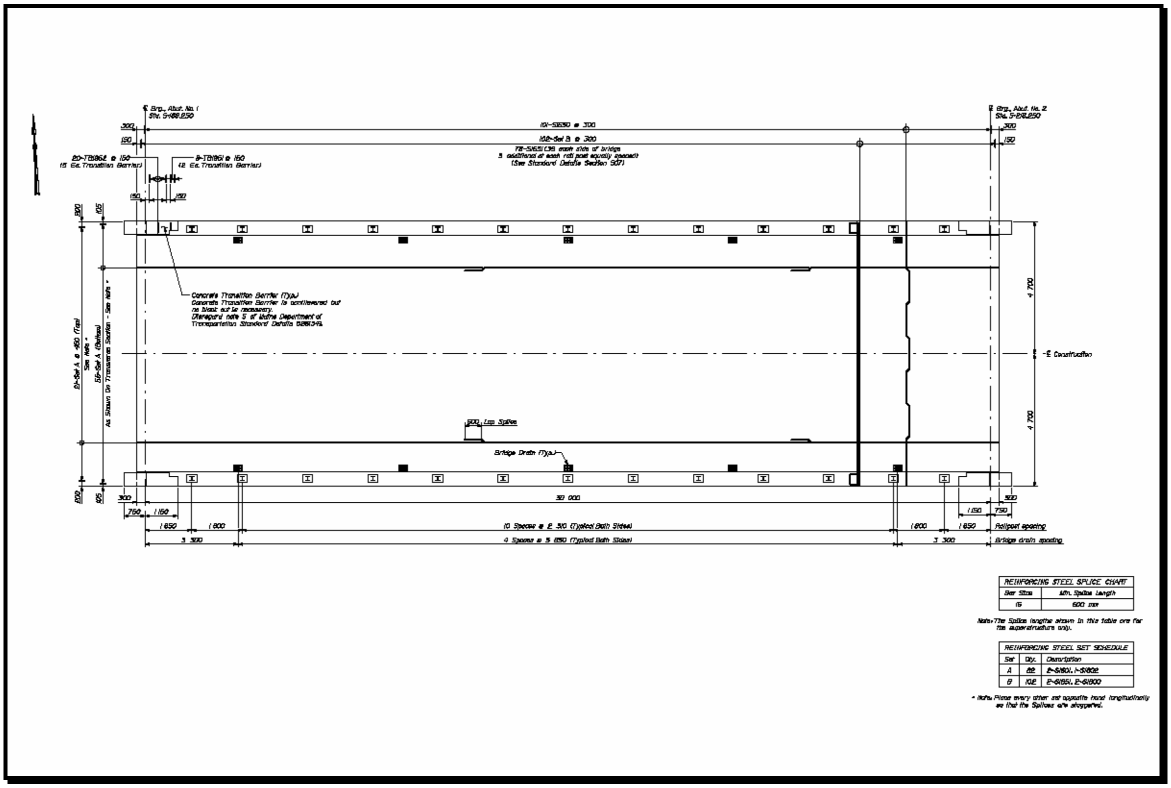

Figure 4-5 Steel Girder Superstructure Plan

Intro: Top view, shows relationship of superstructure limits to substructure centerlines. Also used to communicate reinforcing layout and rail system.

Sheet-up: Belongs on top left of superstructure sheet. Sometimes it is necessary to cut the plan and show on more than one sheet.

♬ When cutting is required, make sure to include an element in both plans, i.e. cut near a pier and show the pier on both plans.

> ⓘ **Make sure to not label the same reinforcing bar(s) twice – if any bar is shown on both plans, only label it on one plan.**

Scale: ¼”. You may need to reduce the size of the plan to help fit it on the sheet. 3/16” or 1/8” are not out of the question. Bear in mind that you’ll be detailing reinforcing steel on the section, however, and consider splitting a superstructure that is too long to fit on one sheet.

Draw:

1) Limits of concrete (show fascia, don’t show beam blocking or hidden lines for shear keys under curbs)
2) Centerlines of bearing of substructures
3) Centerline of Construction / Working Lines
4) Face of curb
5) Rail System (Bridge Rail, Rail Posts & Centerline of Rail Posts, Concrete Transitions Barriers, Concrete Barriers, etc.)
6) Bridge Drains & Centerline of Bridge Drains
7) Reinforcing Steel
8) Construction Joints

Dimension:

1) Spans (CL Bearing Abut to Pier and/or Abut, along working line)
2) Rail Post Spacing (dimensioned along face of rail, tied to intersection of CL Bearing Abut with fascia) Note: This is a curved dimension on a curved superstructure.
3) Skew of substructures
4) Bridge Drain Spacing (dimensioned along fascia, tied to intersection of CL Bearing Abut to fascia)
5) End of slab (limits of concrete, dimensioned parallel to CL Bearing Abut, tied to intersection of CL Construction and CL Bearing Abut)
6) Reinforcing steel (laps & locations)
7) Distance from CL Bearing Abut to End of Slab (show on integral abutments only, dimensioned perpendicular to CL Bearing)

Label:

1) CL of substructure bearings
2) Centerline of construction/working line
3) Stations at CL of Bearings of substructures
4) Stations of Working Points
5) Detail Name “SUPERSTRUCTURE PLAN”
6) North
7) Section/Detail Cuts
8) Rail Post Spacing

9) Rail System (Bridge Rail, Concrete Barrier, CL of Rail Post, End Treatments, etc.)
10) Bridge Drains
11) Reinforcing Steel

4.2.6.2 Transverse Section

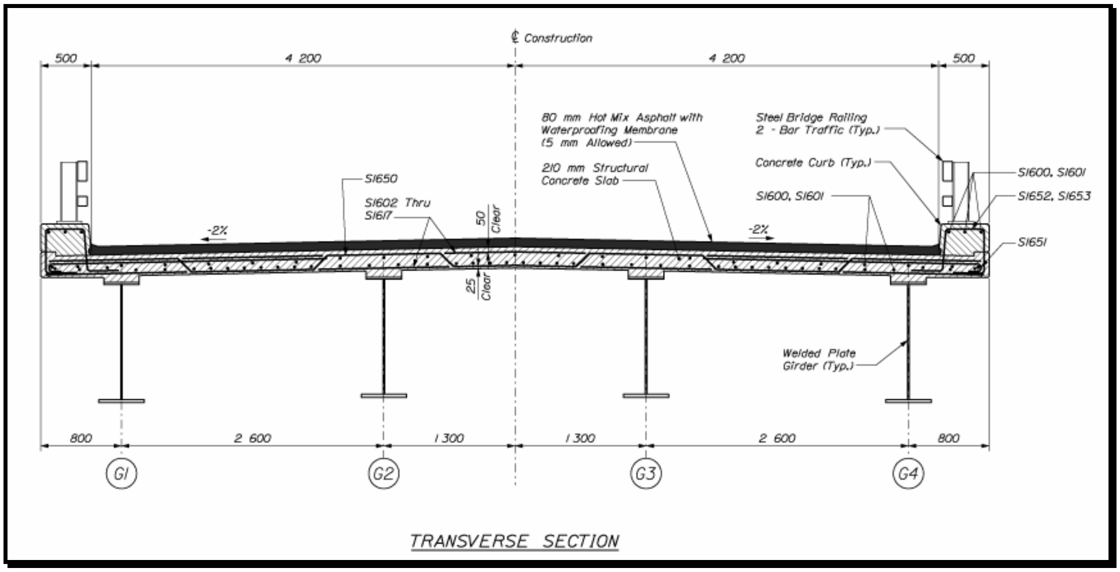

Figure 4-6 Steel Girder Transverse Section

Intro: A section cut through the superstructure normal to the centerline of construction, cut looking upstation. This section shows the relationship of the cast-in-place slab with the girders, plus the roadway elements and reinforcing steel.

Sheet-up: Belongs on the superstructure sheet below the plan.

Scale: ½”. Wide bridges (40’±) might require 3/8” scale.

Draw:

1) Centerline of Construction / Working Line
2) Centerline of Beams
3) Finished grade
4) Bottom of pavement/top of slab
5) Bottom of slab w/beam haunches
6) Pavement should be shaded
7) Concrete should be hatched with adjacent placements showing alternating hatching from 45 to 135 degrees.
8) Steel beams (w/steel hatching)
9) Curbs
10) Rail system (bridge rail, barriers, etc.)

11) Reinforcing Steel
12) Utilities (i.e. conduits suspended from structure)
13) Bridge Drains
14) Lighting
15) Construction Joints

Dimension:

1) Overall superstructure width
2) Centerline to curb width
3) Face of curb to fascia width
4) Girder spacing & overhang (overhang should be dimensioned as "varies" on a curved bridge with straight girders)
5) Reinforcing cover (top and bottom)
6) Construction Joints

Label:

1) Centerline of Construction/Working Line
2) Slab Thickness
3) Reinforcing steel
4) Rail System
5) Wearing Surface and Membrane
6) Cross-slope
7) Curb
8) Beams
9) Utilities
10) Detail Name "TRANSVERSE SECTION"
11) Construction Joints

4.2.6.3 End of Slab Sections

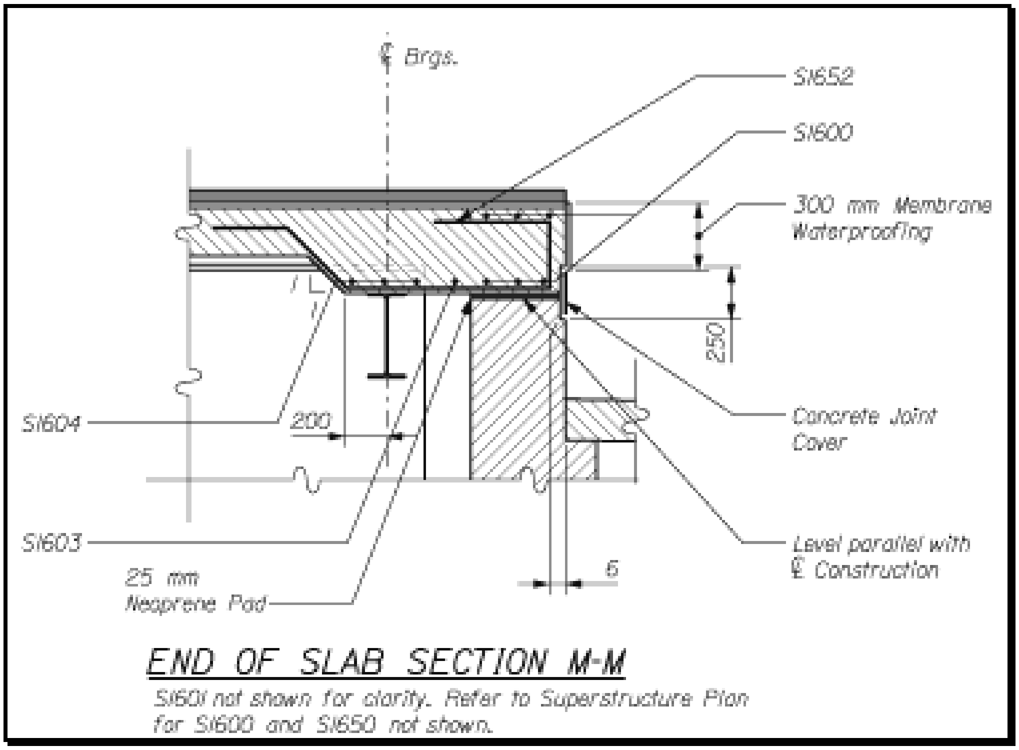

Figure 4-7 Steel Girder End of Slab Section

Intro: End of Slab Sections are cut perpendicular to CL Bearing Abutment. They are typically required when you need to show end of slab haunches, slab over backwall, or joints. The section is primarily required to show reinforcing steel, but also helps clarify joint treatments.

Sheet-up: End of Slab Sections should be put on the Superstructure sheet along with the Superstructure plan and the transverse section. They may also be included on a superstructure details sheet.

Scale: ½”

Draw:

1) Superstructure concrete
2) Abutment concrete
3) Wearing Surface
4) Concrete Joint Cover
5) Steel Girder
6) Centerline Bearings Abutment
7) Reinforcing Steel (typically you only show the additional end-of-slab steel and omit bars that are clearly denoted by the superstructure plan/transverse section)
8) For slab over backwall, show any materials that may be present in the superstructure/abutment interface (neoprene pad, etc.)

9) End Diaphragms

Dimension:

1) Haunch location
2) Extension of Membrane down back of slab
3) Width and depth of concrete joint cover

Label:

1) Centerline of Bearings
2) Detail Name
3) Reinforcing Steel
4) Joint Cover
5) Neoprene Pad
6) Membrane
7) Slope of Haunch (Rise/Run)

4.2.6.4 Camber Diagram

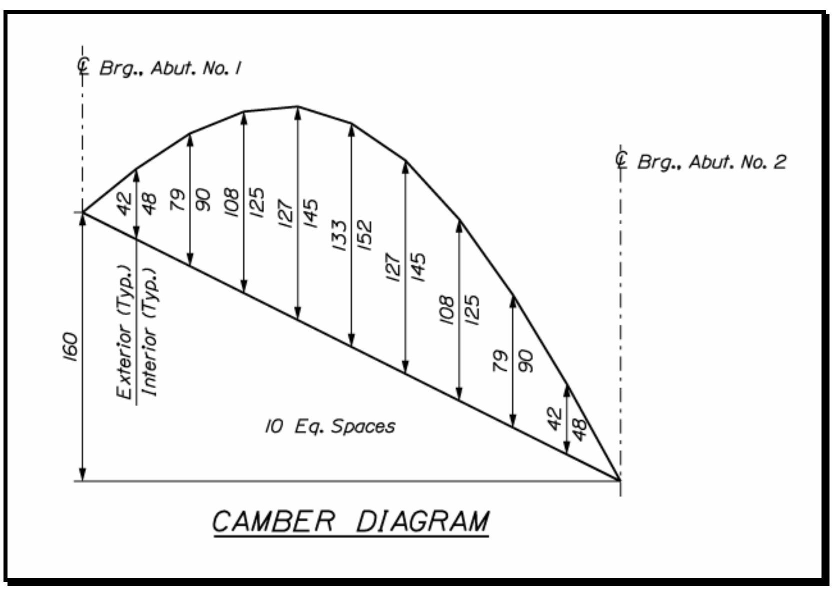

Figure 4-8 Camber Diagram

Intro: This diagram is a structural steel fabrication detail. It is cut parallel to the girders and shows an elevation-type view of the girder, abutment to abutment. It is used to communicate deflection information to the fabricator to assist in the manufacture of welded girders. It is sometimes accompanied by a Camber Table.

Sheet-up: This detail belongs on either the Framing or the Superstructure Details sheets.

Scale: Starting Point/Rule of Thumb: Horizontal Scale 1/16", Vertical Scale 1 ½" to 3". This detail is diagrammatic in nature and there is no need to draw either horizontally or vertically to scale.

Draw:

1) Centerlines of bearing of substructure
2) Centerlines of splices
3) Working Line
4) Vertical Centerline of Beam

Dimension:

1) Locate all camber points relative to centerlines of bearing of substructure and splices (horizontal dimension)
2) Vertical offset of Centerline of beam from the working line at each camber point (this is the camber ordinate) The old common practice was to set the camber ordinates at 10 foot increments, but the ASSHTO/NSBA Steel Bridge Collaboration recommends 10 equal spaces on short span bridges. If these spaces exceed twelve feet, then increase the number of spaces.
3) Vertical offset of working line to lowest point at centerlines of splices and bearings.

Label:

1) Centerlines of bearings
2) Centerlines of splices
3) Centerline of beam
4) Working line
5) Detail Name ("CAMBER DIAGRAM")

4.2.6.5 Slab Haunch and Blocking Detail

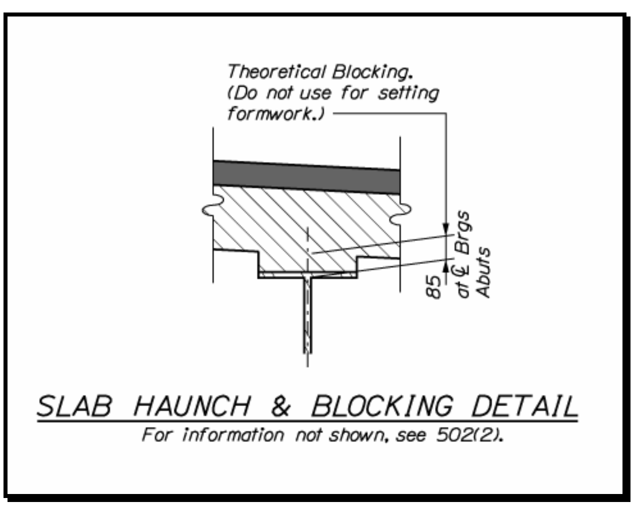

Figure 4-9 Steel Girder Slab Haunch and Blocking Detail

Intro: This detail is cut normal to the centerline of the steel girders. It shows the theoretical blocking thicknesses at the bearing lines.

Sheet-up: This detail belongs either on the Superstructure sheet or on a superstructure details sheet.

Scale: ½"

Draw:

1) Top of Slab
2) Bottom of slab
3) Hatch concrete
4) Wearing Surface (Shaded)
5) Centerline of Girder
6) Top flange and web of girder
7) Haunch

Dimension:

1) Theoretical blocking

Label:

1) "Theoretical Blocking. Do not use for setting formwork."
2) Detail Name

4.2.6.6 Bottom of Slab Elevation Layout Plan

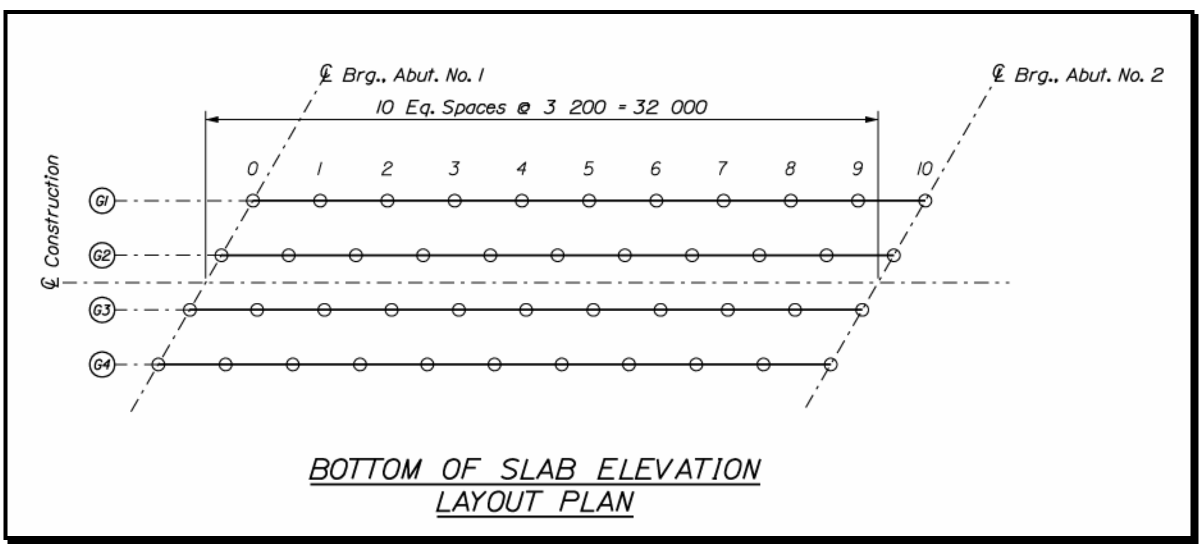

Figure 4-10 Steel Girder Bottom of Slab Elevation Layout Plan

Intro: This plan is a companion to the Bottom of Slab Elevation Table and the Dead Load Deflections Tables. These tables reference blocking points, and this plan helps clarify the location of these blocking points.

Sheet-up: This plan and the companion tables belong on a Superstructure Details Sheet

Scale: 1/16", but this detail is diagrammatic, and doesn't need to be to scale.

Draw:

1) Centerline of construction / Working Line
2) Centerline of substructure bearing
3) Centerlines of girders
4) Girders
5) Blocking Points

Dimension:

1) Blocking point spacing, referenced to Centerlines of bearing of substructures.

Label:

1) Centerline of construction / Working Line
2) Centerlines of girders
3) Centerlines of substructure bearing
4) Detail Name "BOTTOM OF SLAB ELEVATION LAYOUT PLAN"
5) Blocking Points

4.2.6.7 Framing Plan

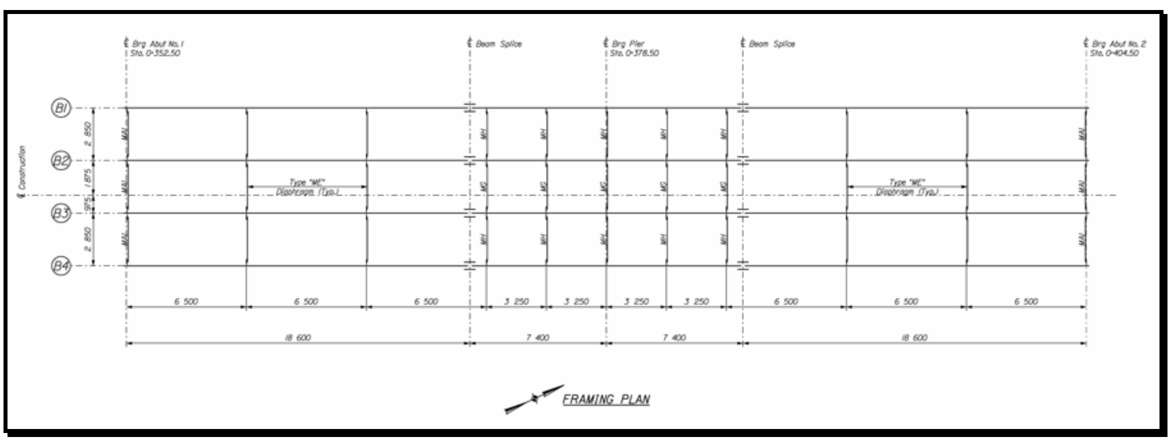

Figure 4-11 Steel Girder Framing Plan

Intro: This is a top view of the structural steel. It shows the spacing of the girders and the locations of splices, diaphragms, pedestals, etc.

♬ Many of the elements shown in the Framing plan (i.e. diaphragms, stiffeners, and bracing) are drawn diagrammatically only.

Sheet-up: Belongs on a Framing Plan Sheet

Scale: ¼" Usually the same as the superstructure plan, but since it shows less detail, it may be shown smaller than the superstructure if necessary: 3/16" or 1/8"

Draw:

1) Centerline of Construction/Working Line
2) Centerlines of Bearing of Substructure
3) Centerlines of Girders
4) Centerlines of Beam Splices
5) Girders
6) Diaphragms
7) Diaphragm connection plates
8) Transverse stiffeners
9) Lateral bracing
10) Longitudinal Stiffeners
11) Splices

Dimension:

Transverse dimensions tied to intersection of CL Brg. Abuts and CL Construction/Working Line (Working Point), longitudinal dimensions tied to CL Bearing Abut.

1) Span Lengths
2) Girder Spacing (& Girder-to-girder skewed dimension for skewed bridge)
3) Diaphragm Locations.
4) Splice Locations.
5) Longitudinal Stiffener length and location
6) Skew
7) Transverse Stiffener Locations

Label:

1) Detail Name "FRAMING PLAN"
2) North
3) Centerline of Construction/Working Line
4) Centerlines of Substructure
5) Bearing Type (for steel bearings only)
6) Centerlines of Splices
7) Girder Number/Designation (i.e. B1, B2, etc.)

8) Diaphragm Types
9) Transverse Stiffeners
10) Longitudinal Stiffeners
11) Lateral Bracing

4.2.6.8 Beam Elevation and Stud Layout

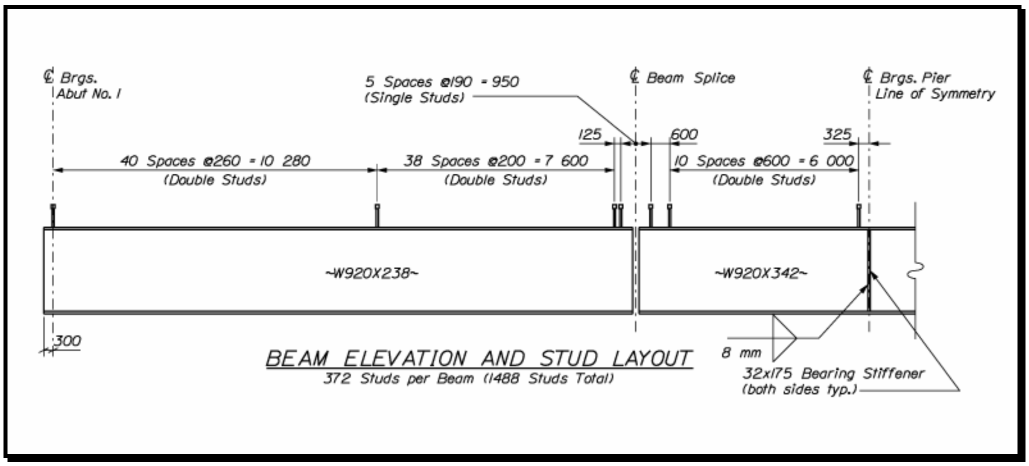

Figure 4-12 Steel Girder Beam Elevation and Stud Layout

Intro: Side view of beam. Primarily serves to show beam size. Also used to clarify stiffeners, splices, and shear connector studs.

ⓘ **Shear studs interfere with the bottom mat of superstructure rebar. This reinforcing steel can be adjusted in the field to clear the studs. Make sure that double or triple studs are oriented parallel to the direction of the reinforcing steel, which will be either normal to the girders or parallel to the skew. This should be noted on the plans.**

Sheet-up: Belongs on framing plan sheet, directly below framing plan.

Scale: Horizontal scale equal to framing plan, typically ¼", but possibly as small as 1/8". Vertical direction doesn't need to be to scale, but is typically shown as 3/8" or greater.

Draw:

1) CL Brg. Substructures
2) CL Splices
3) Beam
4) Shear studs
5) Stiffeners
6) Cover Plates

Dimension:

1) Shear stud layout
2) Beam overhang (length of beam beyond CL Bearing Abuts)
3) Haunch length (haunched girder only)
4) Cover Plate Locations
5) Difference in flange plate thicknesses at shop splices (welded girders only.)

Label:

1) CL Brg. Substructures
2) Detail Name "BEAM ELEVATION AND STUD LAYOUT"
3) Beam sizes (flange and web plate sizes of welded girders)
4) Stiffener sizes
5) Cover Plate Sizes
6) Welds
7) Total Number of Studs Per Girder and per project (noted under the detail name).

4.2.6.9 Field Splice Details

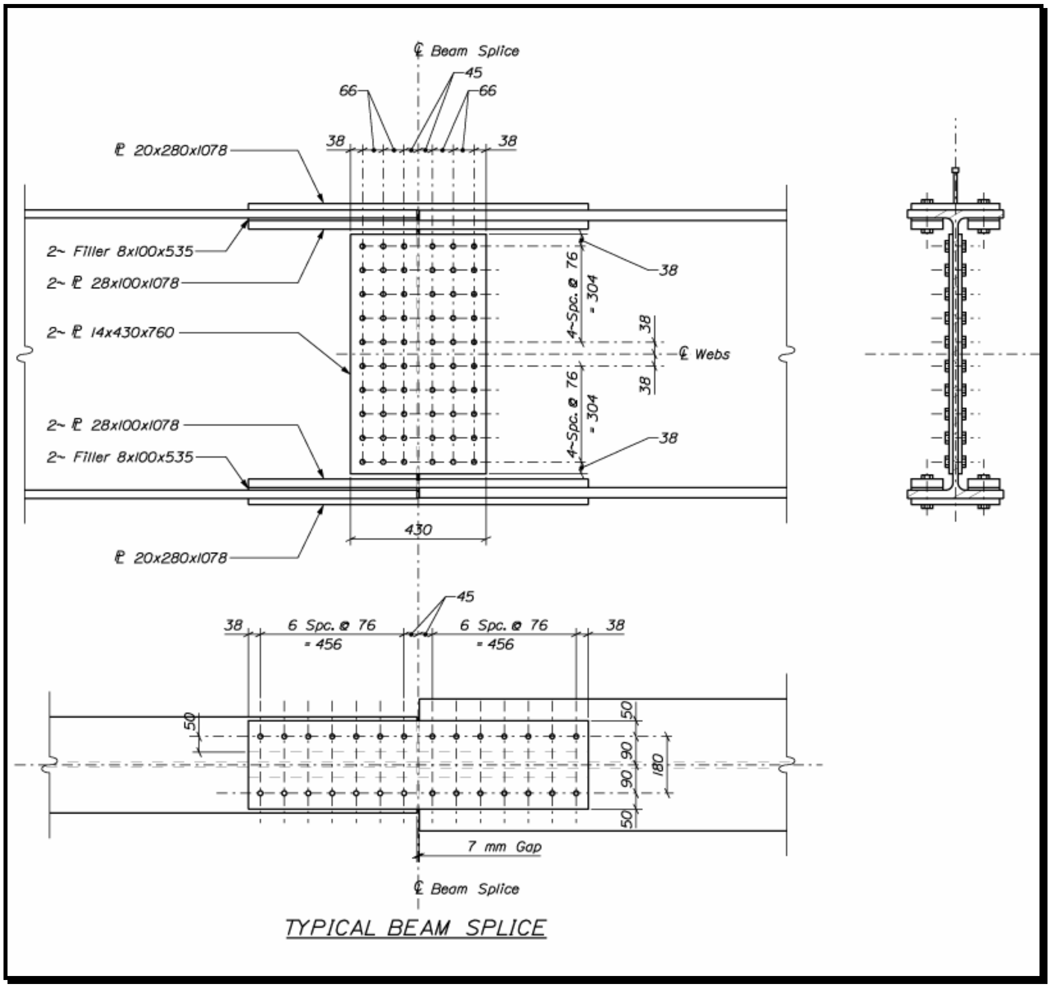

Figure 4-13 Steel Girder Field Splice Details

Intro: This is a three-for-one detail, including a plan, section, and elevation of a field splice. The purpose of these details is to clearly denote all steel plate and bolt sizes and locations.

- If top and bottom flange splices are different, a top view and a bottom view are both required.

Sheet-up: Belongs on a Framing Plan Sheet. The plan and elevation should be shown one on top of the other with CL of Splices aligned, while the Section and Elevation should be shown to the left and right of each other with the CL of Webs aligned.

Scale: 1" or 1 ½"

Draw:

1) CL of Beam Splice
2) CL of Webs of Beams (both horizontal and vertical)
3) Beams

4) Plates
5) Bolts

Dimension:

Each dimension should be shown in only one view (no duplications) All dimensions should be tied to the Beam Splice and to the CL of Web. Where possible, bolt location should be tied to the ends of plates as well. Dimensions are typically not shown in the section view.

1) Gap between beams (typically ¼")
2) Flange bolt locations
3) Web bolt locations

Label:

1) CL of Beam Splice
2) CL of Web
3) Plate sizes

ⓘ **Filler Plate Thicknesses Should Not Be Given**

4) Detail Name "TYPICAL BEAM SPLICE"

4.2.6.10 Beam Stress Type Diagram

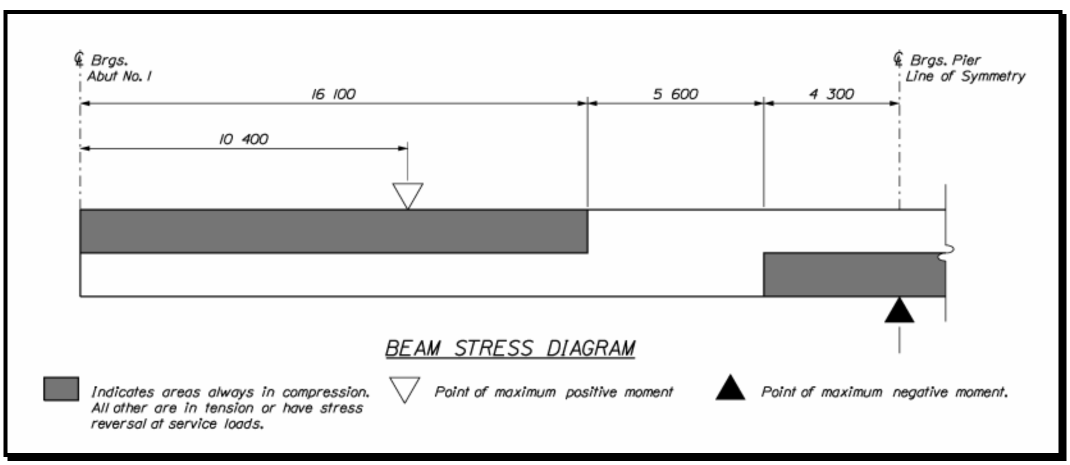

Figure 4-14 Steel Girder Beam Stress Type Diagram

Intro: This detail is a diagrammatic side/elevation view of continuous beams. It shows which portions of the beam are in compression, tension, or stress reversal. It also shows the points of maximum negative and positive moment. All of this information is used by the fabricator to design connections along the length of the girder.

↳ Refer to Notes 4, 5 and 7 of the *Standard Details* Page 504(22) and Standard Structural Note 2 of *Bridge Design Guide* Page D-10.

Sheet-up: Belongs on the Framing Plan

Scale: Not to scale. Draw the same as the Beam Elevation and Stud Layout plan (Section 4.2.6.8, above)

Draw:

1) Beam
2) CL Bearings Substructure
3) Shade areas always in compression

Dimension:

1) Limits of areas always in compression
2) Locations of points of maximum positive and negative moment

Label:

1) Detail Name
2) CL Bearings Substructure
3) Points of Maximum Positive and Negative Moment
4) Legend

4.3 Precast Voided Slab/Box

4.3.1 Introduction

This section deals with the detailing of precast voided slabs and precast boxes. The superstructure may be comprised of a cast-in-place deck on spread boxes, a topping slab on butted boxes/slabs, or neither.

4.3.2 Prerequisites

The Superstructure plans show precast unit details, layout, and superstructure C.I.P. concrete leveling slab, wearing surface, bridge rail, drains.

To draw the superstructure up to completion, the detailer requires the following information:

1) CL Bearings Abutment and Pier Stations
2) Substructure Skew Angle
3) Span Lengths (Pay attention to relationship of CL Construction and Working Line of a curved bridge. Refer to Chapter 2 for guidance.)
4) Joint Locations (Construction & Contraction)
5) Roadway width and cross-slope
6) Curb/Sidewalk widths
7) Wearing Surface Type and Thickness
8) Slab Type & Thickness (Topping vs. Structural Slab)
9) Rail Type
10) Rail Post Locations (can be developed by detailer from standard detail information.)
11) Panel Spacing & Slab Overhang (spread panels only)
12) Precast Unit Type and nominal size
13) Precast Unit Layout
14) Panel length and relationship of end-of-panel to CL Bearings Substructure
15) Blocking Height (spread panels only)
16) Diaphragm Spacing (spread panels only)
17) Bearing Type and thickness
18) Completed and checked reinforcing schemes:
    a. Curbs and Sidewalks
    b. Superstructure Slab (spread panels only)
    c. Precast Shear Reinforcing Sets
    d. Precast End-of-panel hairpins

   e. Top Slab Reinforcement for Box Beams (for Strength and Distribution)
   f. Pier Continuity Reinforcement (as req'd)
   g. Post-tensioning lock-off reinforcement (as req'd)
   h. Dowel Size and Spacing (to anchor to substructure)

19) Completed and checked prestressing scheme (strand number, location, debonding limits, etc.)
20) Completed and checked post-tensioning scheme
21) Void geometry (size, location, length)
22) Superstructure and Precast Notes
23) Bridge Drain Type & Locations
24) Bottom of Slab Grades (spread panels only)
25) Sketch of Blocking Point Layout Diagram (spread panels only)
26) Utility Size, Type, and Location

4.3.3 Detailing

Precast Voided Slabs/Boxes require explicit rather than performance-based details. A vast majority of the details are to serve the needs of the Fabricator rather than the Contractor. The Superstructure Plan and Transverse Section are used by the Contractor to erect the structure. The precast sheets and their details are provided for the Fabricator.

There are standards developed for the northeastern United States by the Precast Concrete Institute which should be used for designing and detailing plans. Consult the Bridge Program concrete Technical Resource person for more information.

4.3.4 Typical Sheet Names and Contents

4.3.4.1 PRECAST VOIDED SLAB/BOX

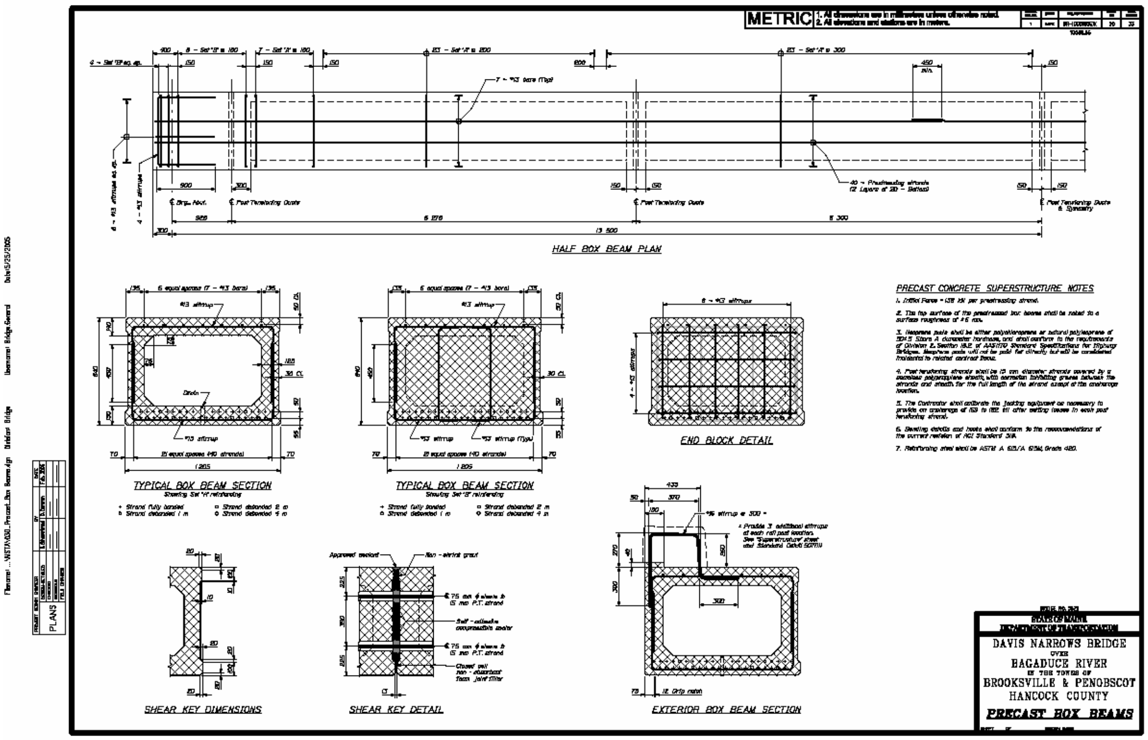

Figure 4-15 Precast Box Sheet

Will Contain:

1) Precast Voided Slab/Box Plan
2) Typical Sections

May Contain:

1) Notes
2) Longitudinal Section
3) Reinforcing Steel Schedule

4.3.4.2 PRECAST VOIDED SLAB/BOX DETAILS

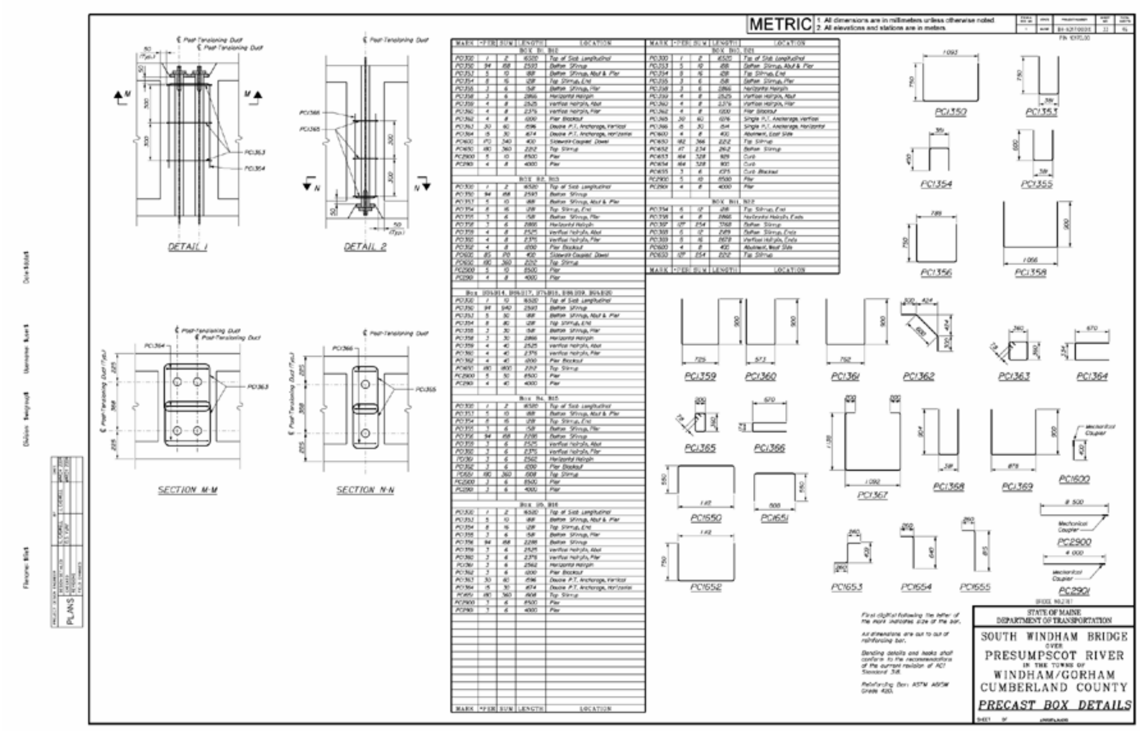

Figure 4-16 Precast Box Details Sheet

Will Contain:

1) Reinforcing Steel Schedule

May Contain:

1) Post-tensioning details and sections
2) Longitudinal Section
3) Other details/sections
4) Notes

4.3.4.3 SUPERSTRUCTURE

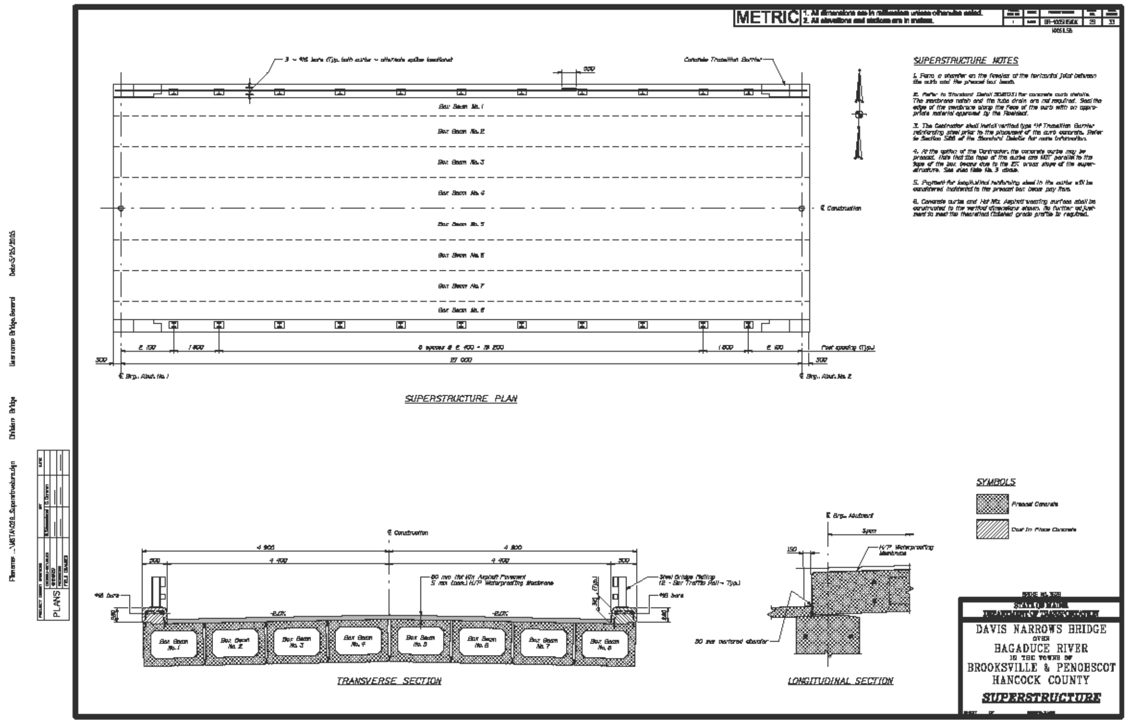

Figure 4-17 Precast Superstructure Sheet

Will Contain:

1) Superstructure Plan
2) Transverse Section

May Contain:

1) Notes
2) Other Details

4.3.4.4 SUPERSTRUCTURE DETAILS

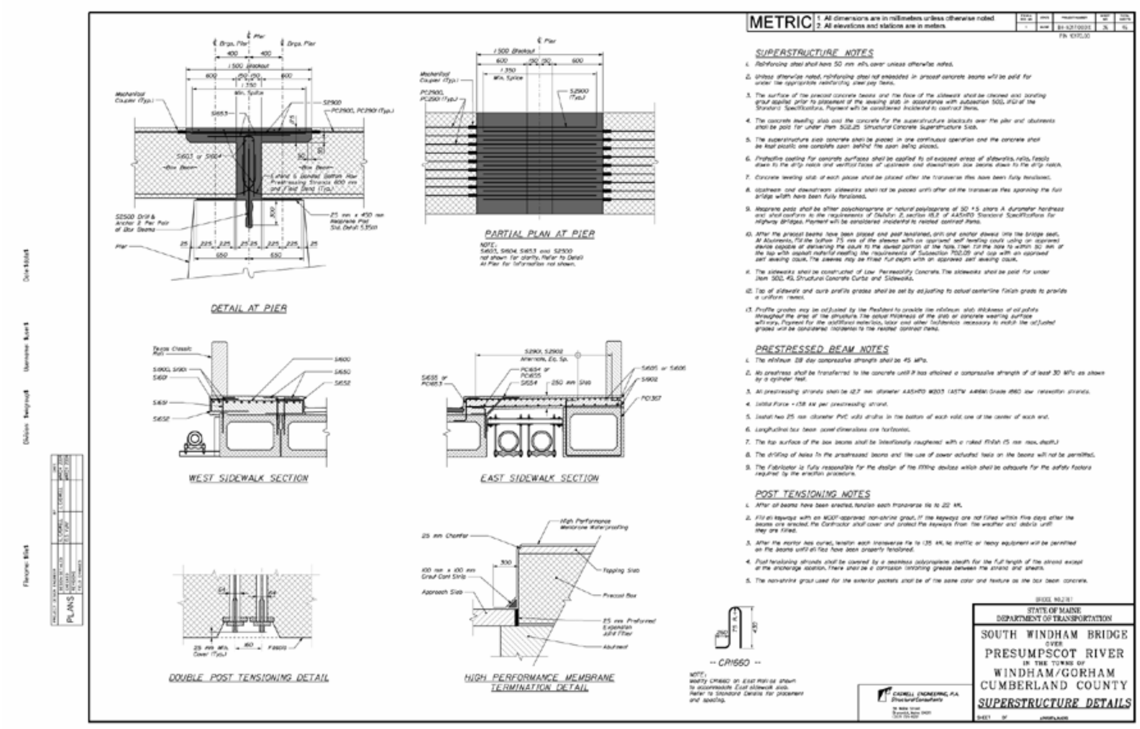

Figure 4-18 Precast Superstructure Details

May Contain:

1) Notes
2) Bottom of Slab Elevation Table/Layout Plan (spread boxes)
3) Bridge Drain Details
4) Slab End Details
5) Bearing Layout Details
6) Post-tensioning Details
7) Utility attachments
8) Beam Splice Details

4.3.5 Standard Notes

4.3.5.1 Precast Concrete Superstructure Notes

1) Prestressing strands shall be 0.5 inch diameter. The tensioning force is 31 kips per prestressing strand.
2) Prestressing strands shall be 0.6 inch diameter. The tensioning force is 44 kips per prestressing strand.

3) The top surface of the upper flange of the prestressed beams shall be raked to a surface roughness of plus or minus 1/4", except at locations corresponding to the blocking points. At these locations a flattened area of sufficient size shall be left to facilitate taking elevations for setting bottom of slab elevations.
4) The drilling of holes in the prestressed beams and the use of power-actuated tools on the beams will not be permitted.
5) Neoprene pads shall be either polychloroprene or natural polyisoprene of 50±5 Shore A durometer hardness, and shall conform to the requirements of Division 2, Section 18.2 of AASHTO Standard Specifications for Highway Bridges. Neoprene pads will not be paid for directly, but will be considered incidental to related Contract items.
6) Install a 1 inch diameter nonmetallic void drain in the bottom of each void at both ends.
7) Reinforcing steel shall have 2 inches minimum cover unless otherwise noted or shown.
8) Post-tensioning strands shall be covered by a seamless polypropylene sheath, with corrosion inhibiting grease between the strands and sheath, for the full length of the strand except at the anchorage location.
9) The Contractor shall calibrate the jacking equipment as necessary to provide an anchorage of 38 to 41 kips after setting losses in each 0.6" diameter post-tensioning strand.

(The following note is used for all voided slab and butted box beam structures.)

10) Screed rails shall be installed to the elevation shown on the profile, adjusted for wearing course thickness and cross slope.

4.3.6 Checklists

4.3.6.1 Precast Voided Slab/Box Plan

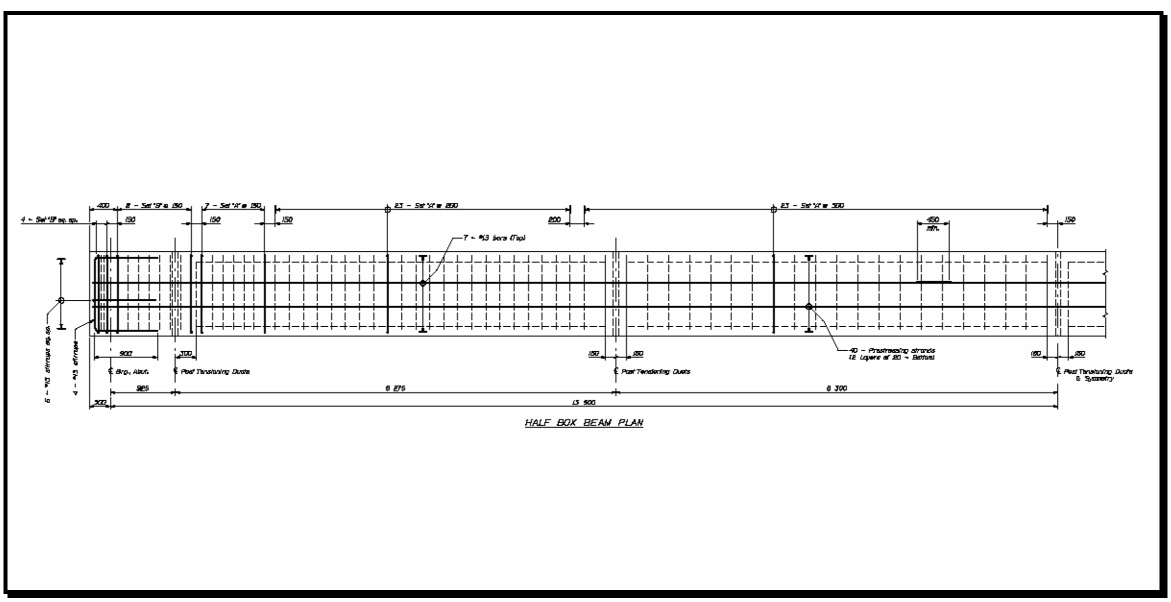

Figure 4-19 Precast Plan

Intro: Top view of precast deck panel.

Sheet-up: Belongs in upper left hand corner of Precast Voided Slab/Box Sheet

Scale: ¼”

Draw:

1) CL of Brgs. Substructure
2) Limits of Concrete
3) Limits of Voids (show void drains)
4) CL of Post-Tensioning Ducts
5) Post-Tensioning Pockets (fascia side only)
6) End Hairpin Reinforcement (shear stirrups should be shown only in transverse and longitudinal sections)
7) PVC Sleeves for Dowels (into Abutment or Pier)
8) Pre-stressing strands (typically show 1 and annotate like rebar)

Dimension:

1) Overall Length of Panel
2) Panel Overhang (CL Brgs. To End of Panel)
3) Locations of Post-Tensioning Ducts
4) Location of PVC Sleeves (for dowels)
5) Void clearance from post-tensioning duct centerline
6) Skew angle

Label:

1) Detail Name
2) CL of Brg. Substructure
3) CL Post-Tensioning Ducts
4) PVC Sleeve
5) Post-Tensioning Pocket (fascia only)
6) Reinforcing
7) Section Cut (for Longitudinal Section / Elevation)
8) North
9) Voids
10) Void Drains

4.3.6.2 Transverse Sections

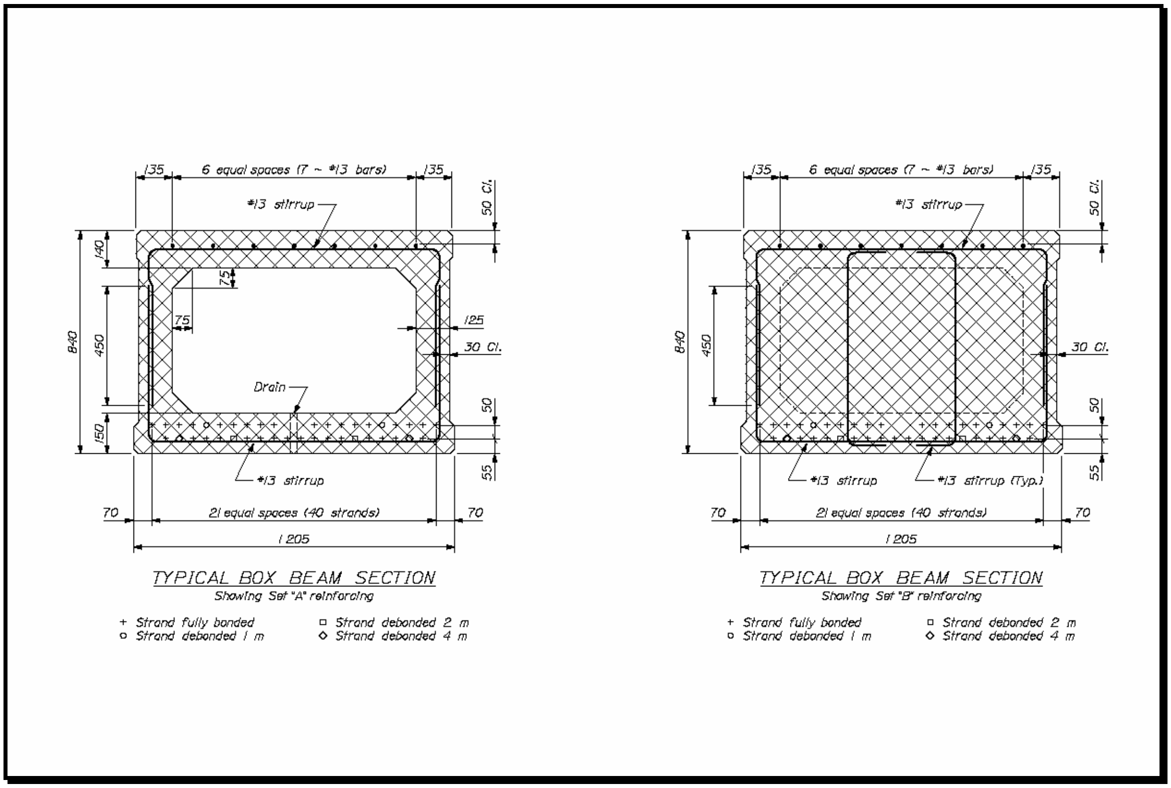

Figure 4-20 Precast Transverse Sections

Intro: Typically either two or three sections (for both the internal and external panels) are required to clearly show the critical locations along the panel. For a simple span with symmetric ends, only two sections are needed: an end section and a mid-span section. For a continuous span, the mid-span section is required, as are separate sections in the vicinity of the abutment and the pier.

Sheet-up: Belongs on the Precast Voided Slab/Box Sheet

Scale: Either 1" or 1 ½"

Draw:

1) Limits of Precast Concrete
2) CL of Panel
3) CL of Voids
4) CL of Prestressing Strands
5) Voids (show hidden in end-span sections)
6) Curbs/Sidewalks (on exterior panels)
7) Prestressing Strands (show debonded strands solid, non-debonded strands hollow)
8) Reinforcing Steel

Dimension:

1) Width of panel
2) Location of Voids (horizontal and vertical)
3) Thickness of Panel
4) Location of Prestressing Mats (CL of top strands to top of panel, CL of bottom strands to bottom of panel.)
5) Spacing of prestressing strands
6) On a box, dimension thickness of top, bottom, and side walls, and void chamfer size
7) On a voided slab, dimension the diameter of the voids

Label:

1) Detail Name
2) CL Panel
3) CL Voids
4) Number of prestressing strands
5) Number of debonded strands and debonded length
6) Reinforcing Steel
7) Legend to differentiate debonded from non-debonded strands

4.3.6.3 Longitudinal Slab/Box Section

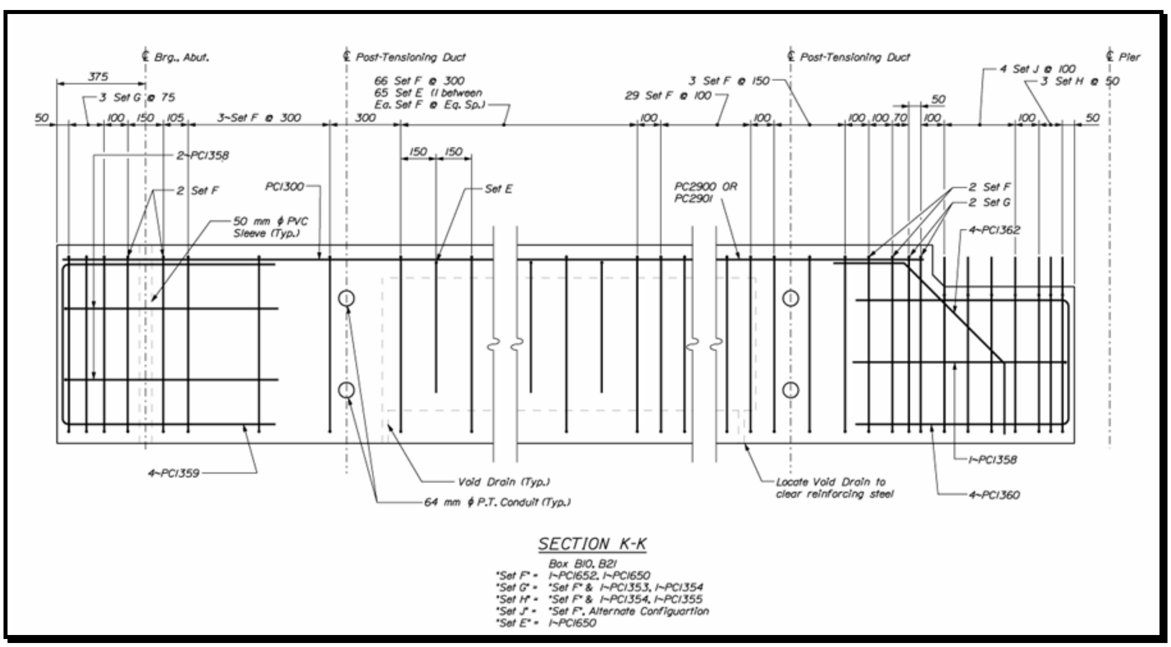

Figure 4-21 Precast Longitudinal Section

Intro: This side view shows the layout of shear stirrup spacing as well as end of slab hairpins. It also serves as the only side view of the panel.

Sheet-up: Belongs either on Precast Voided Slab/Box Sheet or Detail Sheet

Scale: 1" or 1 ½", this section must be cut into a minimum of 3 portions, showing the ends as well as the middle of the panel.

Draw:

1) CL of Brg. Substructures
2) CL Post-tensioning ducts
3) Limits of Concrete
4) Post-Tensioning Conduits
5) Voids and Void Drains
6) Reinforcing Steel

Dimension:

1) Reinforcing Steel

Label:

1) Section Name
2) CL Post-Tensioning Ducts
3) CL Substructures
4) Reinforcing Steel

♬ You may need to conserve space by combining rebar into sets, make sure to include a note or table to clearly define what steel is in what set.

5) Post-Tensioning Conduits
6) Void Drains
7) PVC Sleeves (for dowels)

4.3.6.4 Reinforcing Schedule

Intro: The reinforcing schedule for precast concrete is slightly different from the standard cast-in-place schedule, in that each individual bar is drawn, labeled and dimensioned right in the schedule.

Sheet-up: The Precast Reinforcing Schedule belongs either on a Precast Slab/Box or Details Sheet.

Scale: Not to scale, try ¼" Feel free to draw bars out of scale to help fit them in the schedule.

4.3.6.5 Superstructure Plan

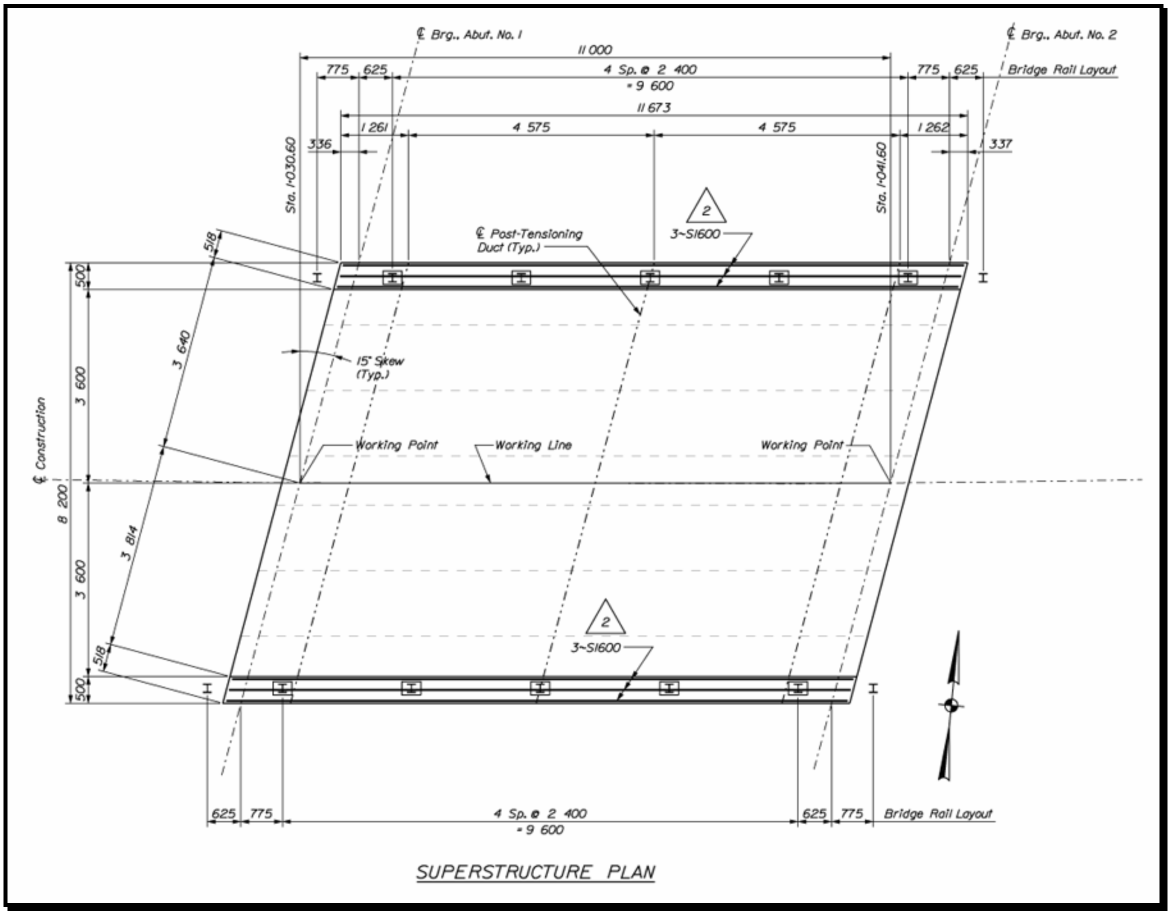

Figure 4-22 Precast Superstructure Plan

Intro: Top view, shows relationship of superstructure limits to substructure centerlines. Also used to communicate reinforcing layout and rail system.

Sheet-up: Belongs on top left of superstructure sheet. Sometimes it is necessary to cut the plan and show on more than one sheet.

- ♬ When cutting is required, make sure to include an element in both plans, i.e. cut near a pier and show the pier on both plans.

> ⓘ **Make sure to not label the same reinforcing bar(s) twice – if any bar is shown on both plans, only label it on one plan.**

Scale: ¼”. You may need to reduce the size of the plan to help fit it on the sheet. 3/16” or 1/8” are not out of the question. Bear in mind that you’ll be detailing reinforcing steel on the section, however, and consider splitting a superstructure that is too long to fit on one sheet.

Draw:

1) Limits of concrete (show fascia, don’t show beam blocking or hidden lines for shear keys under curbs)

2) Centerlines of bearing of substructures
3) Centerline of Construction / Working Lines
4) Face of curb
5) Rail System (Bridge Rail, Rail Posts & Centerline of Rail Posts, Concrete Transitions Barriers, Concrete Barriers, etc.)
6) Bridge Drains & Centerline of Bridge Drains
7) Reinforcing Steel
8) Construction Joints
9) Post-tensioning duct locations
10) Hidden lines for edges of precast panels

Dimension:

1) Spans (CL Bearing Abut to Pier and/or Abut, along working line)
2) Rail Post Spacing (dimensioned along face of rail, tied to intersection of CL Bearing Abut with fascia) Note: This is a curved dimension on a curved superstructure.
3) Skew of substructures
4) Bridge Drain Spacing (dimensioned along fascia, tied to intersection of CL Bearing Abut to fascia)
5) End of slab (limits of concrete, dimensioned parallel to CL Bearing Abut, tied to intersection of CL Construction and CL Bearing Abut)
6) Reinforcing steel (laps & locations)
7) Distance from CL Bearing Abut to End of Slab (show on integral abutments only, dimensioned perpendicular to CL Bearing)

Label:

1) CL of substructure bearings
2) Centerline of construction/working line
3) Stations at CL of Bearings of substructures
4) Stations of Working Points
5) Detail Name “SUPERSTRUCTURE PLAN”
6) North
7) Panel Numbers
8) Section/Detail Cuts
9) Rail Post Spacing
10) Rail System (Bridge Rail, Concrete Barrier, CL of Rail Post, End Treatments, etc.)
11) Bridge Drains

12) Reinforcing Steel

4.3.6.6 Transverse Section

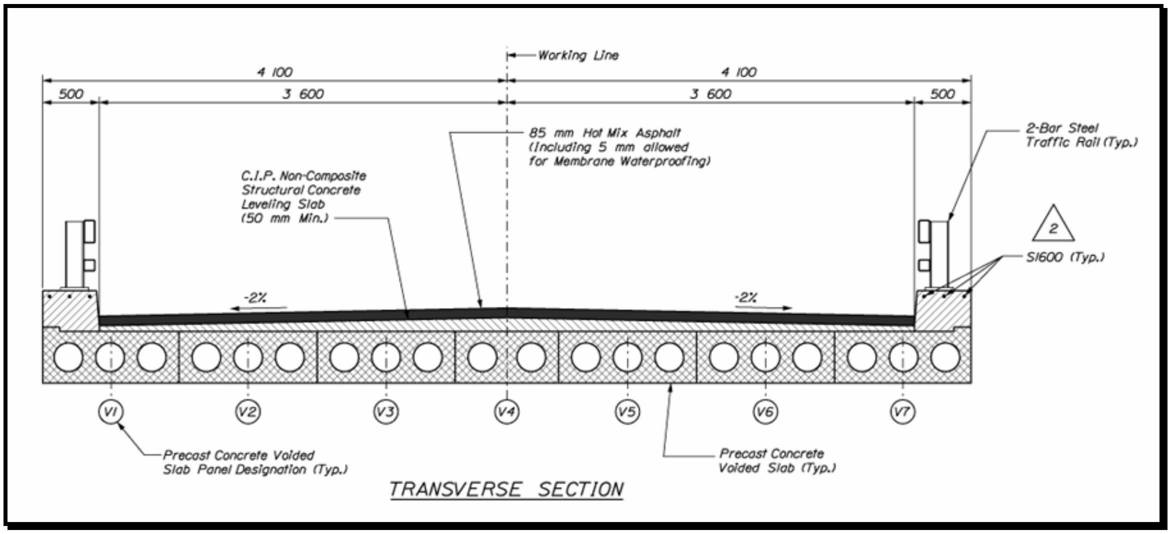

Figure 4-23 Precast Transverse Section

Intro: A section cut through the superstructure normal to the centerline of construction, cut looking upstation. This section shows the relationship of a cast-in-place or topping slab with the panels, plus the roadway elements and reinforcing steel.

Sheet-up: Belongs on the superstructure sheet below the plan.

Scale: ½”. Wide bridges (40’±) might require 3/8” scale.

Draw:

1) Centerline of Construction / Working Line
2) Centerline of Panels
3) Pavement (should be shaded)
4) Topping Slab/Structural Slab (hatched)
5) Precast Panels (cross-hatched)
6) Curbs (hatched)
7) Rail system (bridge rail, barriers, etc.)
8) Reinforcing Steel
9) Utilities (i.e. conduits suspended from structure)
10) Bridge Drains
11) Construction Joints

Dimension:

1) Overall superstructure width

2) Centerline to curb width
3) Face of curb to fascia width
4) Nominal Panel Width
5) Panel spacing & overhang (for spread units only)
6) Reinforcing cover (top and bottom)
7) Construction Joints

Label:

1) Centerline of Construction/Working Line
2) Slab Type and Thickness
3) Reinforcing steel
4) Rail System
5) Wearing Surface and Membrane
6) Cross-slope
7) Curb
8) Panels
9) Utilities
10) Detail Name "TRANSVERSE SECTION"
11) Construction Joints

CHAPTER 5 BURIED STRUCTURES

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5.2 Structural Plate Pipe and Pipe Arch

5.2.1 Introduction

These are corrugated metal structures of either steel or aluminum that are used for short-span crossings. Pipes and Pipe arches are the least expensive and most commonly used buried structures.

5.2.2 Prerequisites

You will need the following:

1) Final Horizontal and Vertical Alignments
2) Skew of structure to CL Construction
3) Station where CL of Structure crosses CL Construction
4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
5) Structure size (rise and span)
6) Inlet and Outlet elevations
7) End Cut of Structure
8) Bedding material type and depth, geotextile usage
9) Toe wall geometry
10) Riprap blanket size, type and location
11) Theoretical streambed elevation
12) Notes

5.2.3 Detailing

Structural Plate Pipes and Pipe Arches require a combination of explicit and performance-based detailing. Earthwork and concrete toe walls are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.2.4 Typical Sheet Names and Contents

5.2.4.1 Pipe/Pipe Arch

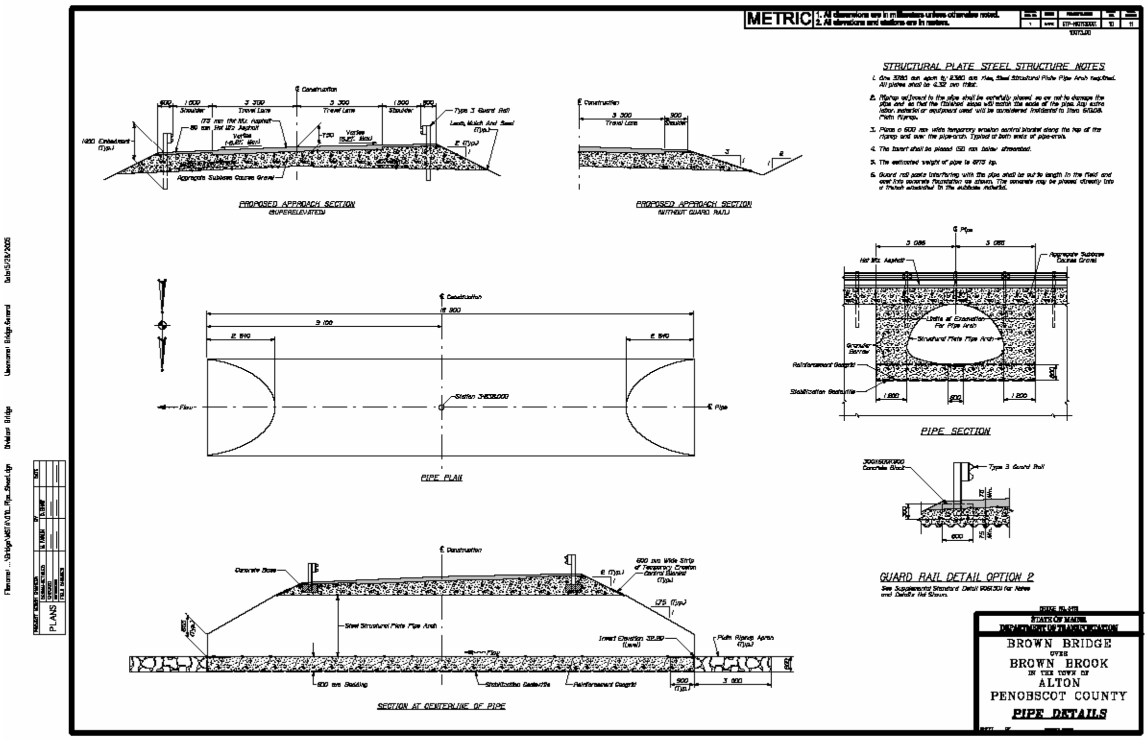


Figure 5-1 Pipe/Pipe Arch Sheet

Will Contain:

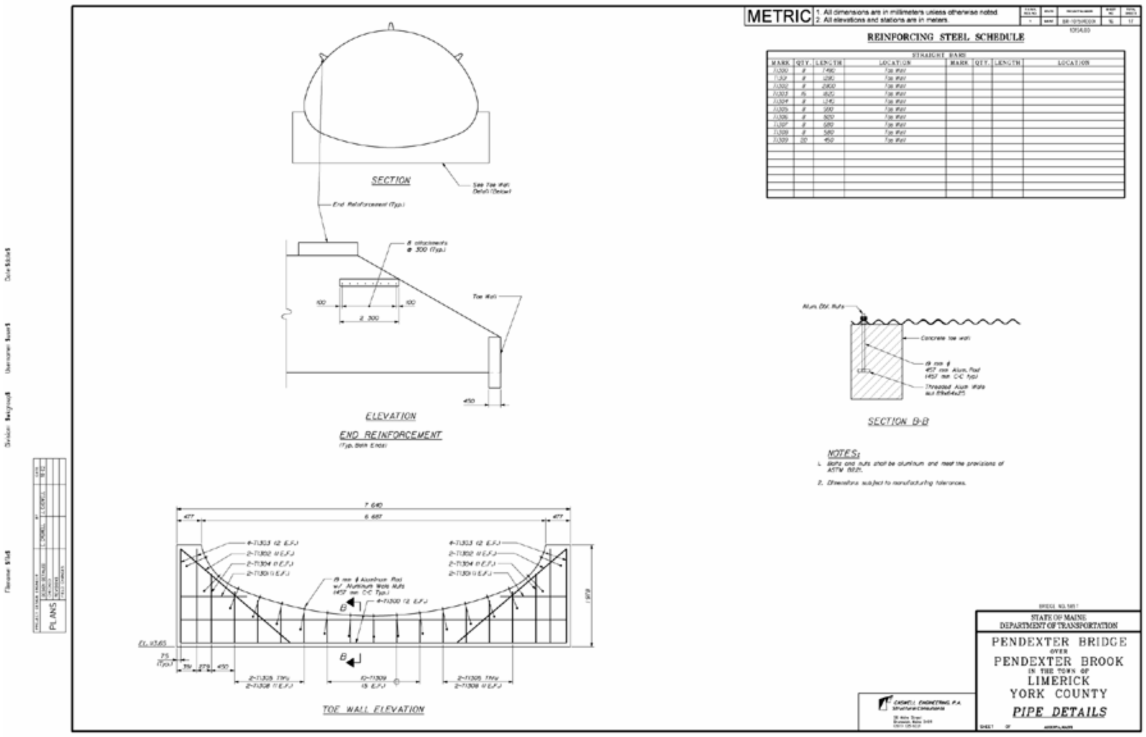
1) Pipe Plan
2) Typical Pipe Section (Longitudinal)

May Contain:

1) Notes
2) Other Sections or Details

5.2.4.2 Pipe/Pipe Arch Details

Figure 5-2 Pipe/Pipe Arch Details Sheet



Will Contain:

1) Additional Details

May Contain:

1) Reinforcing Steel Schedule
2) Notes

5.2.5 Standard Notes

5.2.5.1 Structural Plate Structure Notes

1) One XX inch diameter Structural Plate Pipe is required. Top plates shall be XX inches thick; bottom (three) plates(s) shall be XX inches thick. The pipe shall be elongated 5% vertically.
2) One XX'-XX" span by XX'-XX" rise Structural Plate Pipe Arch required. Top plates shall be XX inches thick; bottom and corner plates shall be XX inches thick.
3) Ends shall be cut on a 1:1.75 bevel normal to the end skew shown on the details.

4) Riprap adjacent to the pipe shall be carefully placed so as not to damage the pipe (pipe arch) and so that the finished slope will match the ends of the pipe. Any extra labor, material, or equipment used will be considered incidental to Item 610.08, Plain Riprap.
5) Place a 2 foot wide temporary erosion control blanket along the top of the riprap and over the pipe (pipe-arch). Typical at both ends of pipe (pipe-arch).

(The following two notes are used for aluminum pipe or pipe arch.)

6) End reinforcement devices shall be of aluminum and shall be of sufficient strength to provide a minimum section modulus, about an axis perpendicular to the center of the pipe of 1.10 in 3 /ft of pipe circumference. Maximum spacing of the devices shall be 5'-5". Attachment to the pipe shall be with 3/4" galvanized steel bolts. Section properties and details of the device and the method of attachment shall be submitted to the Resident for approval.
7) Payment for end reinforcement devices will be considered incidental to Item 509.XX, Aluminum Alloy Structural Plate (Pipe) Arch.

5.2.6 Checklists

5.2.6.1 Structural Plate Pipe or Pipe Arch Plan

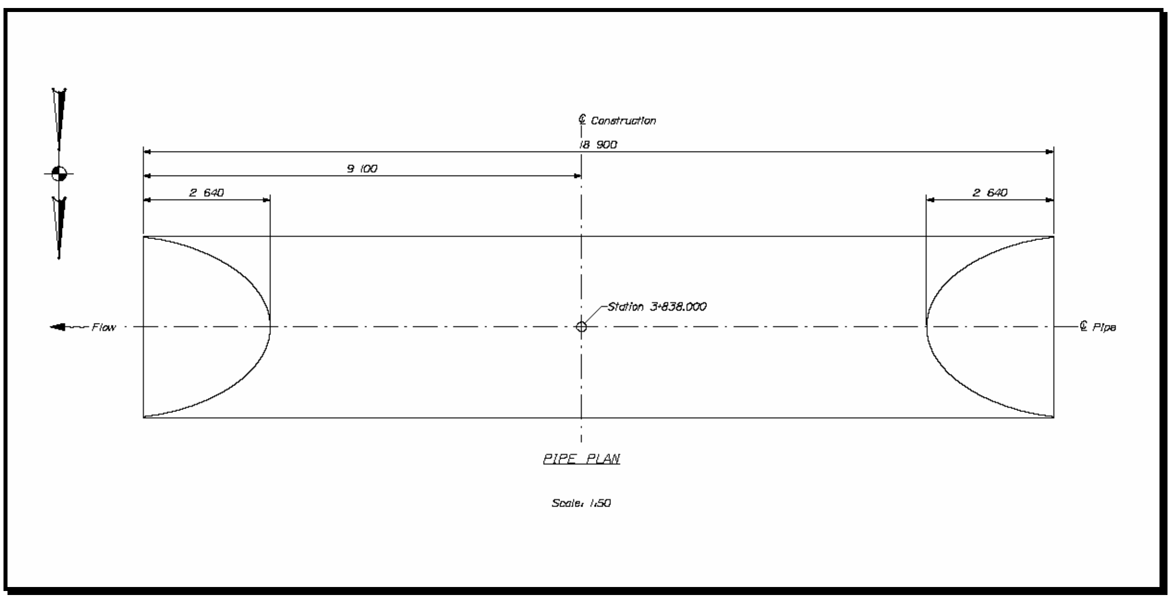


Figure 5-3 Structural Plate Pipe Plan

Intro: Top view of structure, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the pipe/pipe arch sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: ¼". (Check sheet up before proceeding. If plan and longitudinal section won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of structure (pipe or pipe arch)

2) Centerline of Construction/Working Line
3) Centerline of Structure
4) Beveled end cut
5) Construction joint, if required for stage construction
6) Toe wall, if required

Dimension:

1) Limits of structure:
   a) The bottom centerline length from the working point to the upstream and downstream ends.
   b) The top centerline length and end cut length for mitered to slope structures.
   c) Width of structure.
2) Skew angle between CL Structure and line normal to CL Construction/Working Line.
3) Skew angle between end of barrel and line normal to CL Structure, if required.
4) Construction joint

Label:

1) Detail Name
2) CL Construction/Working Line
3) CL Structure
4) North Arrow
5) Flow Arrow
6) Bevel end cut slope, if end cut is skewed
7) Station at intersection of CL Construction/Working Line and CL Structure
8) Construction joint

5.2.6.2 Structural Plate Pipe or Pipe Arch Transverse Section

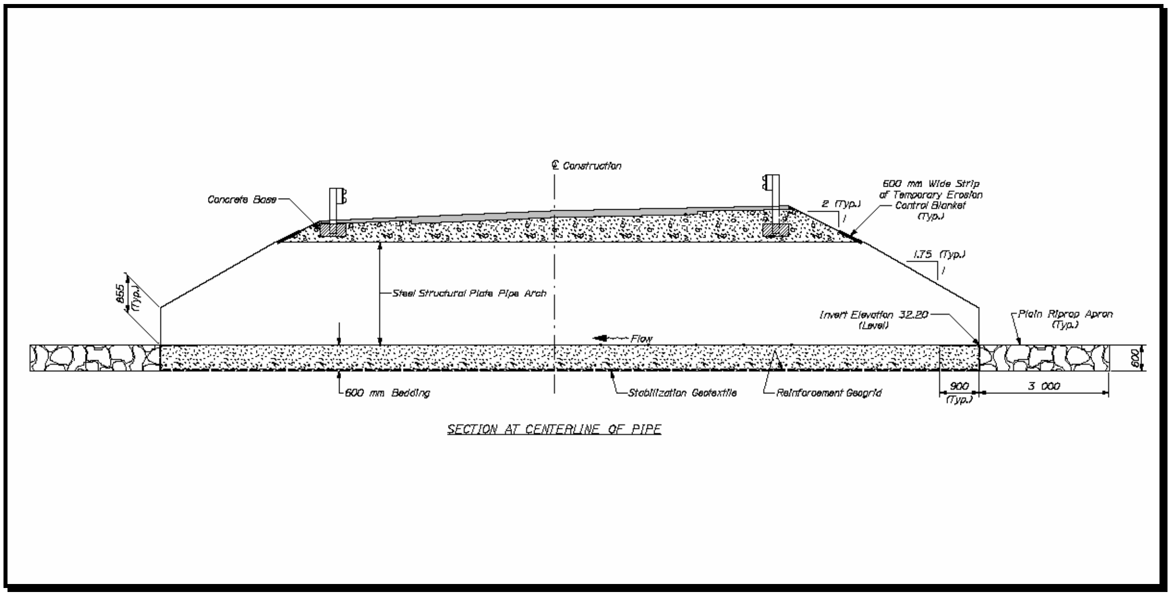


Figure 5-4 Structural Plate Pipe Transverse Section

Intro: Section cut along the CL of Structure, showing the invert elevations and end cut configurations. View is normal to CL of Structure.

Sheet up: Belongs on the Pipe/Pipe Arch Sheet directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically ¼ ".

Draw:

1) Limits of structure
2) Centerline of Construction/Working Line
3) Roadway, guardrail and side slopes.
4) Concrete base for guardrail anchorage, if required.
5) Granular borrow cover over structure
6) Bedding material
7) Riprap blanket
8) Riprap side slopes, if required
9) Existing ground
10) Construction joint, if required for stage construction
11) Toe walls, if required
12) Concrete collar, if required

Dimension:

1) Bottom step cut
2) Width of riprap blanket
3) Roadway widths can be shown here if there is no typical roadway section, and the pipe is not skewed.

Label:

1) Detail Name
2) Invert elevations
3) End bevel slopes.
4) Roadway side slopes, if different from end bevel.
5) Guardrail in concrete base
6) Bedding material
7) Granular borrow cover
8) Riprap blanket

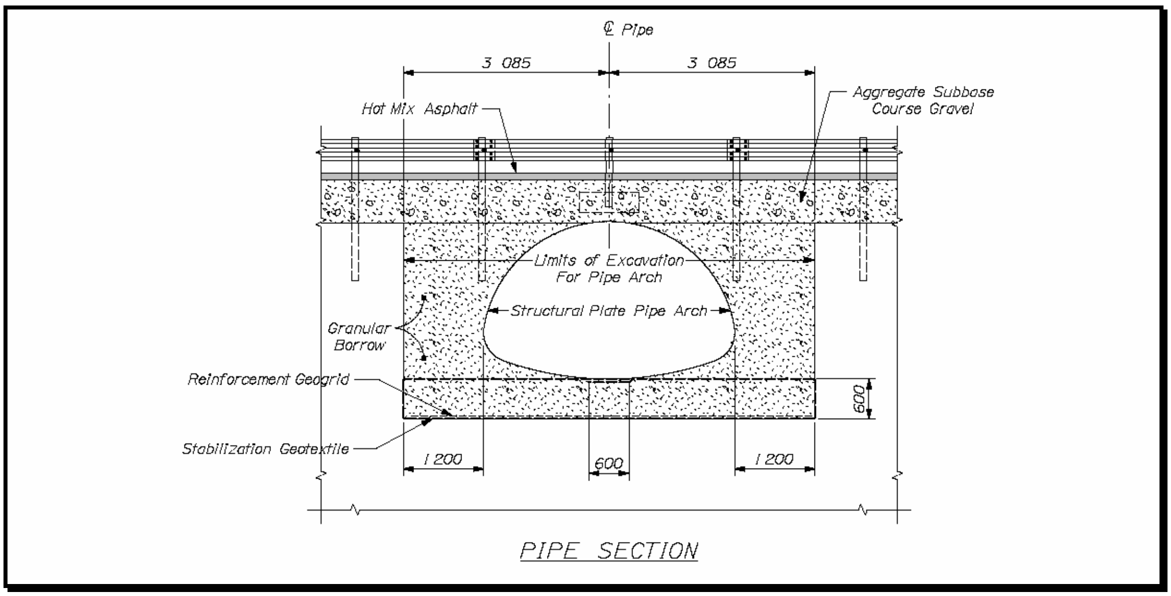


Figure 5-5 Structural Plate Pipe Arch Typical Section

5.2.6.3 Structural Plate Pipe or Pipe Arch Typical Section

Intro: Cross section through pipe or pipe arch showing limits of granular borrow and bedding requirements.

Sheet up: Belongs on Pipe/Pipe Arch Sheet, to the right of the longitudinal section

Scale: Same size as the plan, typically ¼ " or larger if there is room.

Draw:

1) Limits of pipe or pipe arch
2) Limits of granular borrow and bedding materials

Dimension:

1) Limits of granular borrow and bedding materials

Label:

1) Detail Name
2) Granular borrow and bedding materials
3) Granular borrow and structural earth excavation limits

5.2.6.4 Structural Plate Pipe or Pipe Arch End Reinforcing

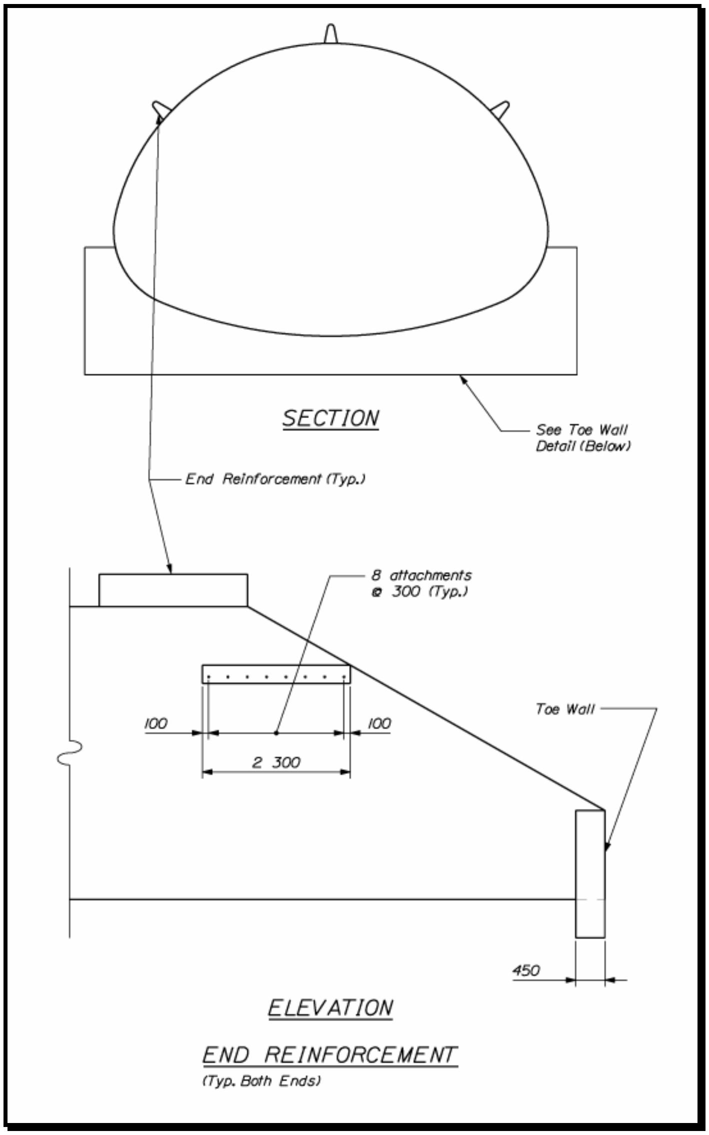


Figure 5-6 Structural Plate Pipe Arch End Reinforcing

Intro: Section and elevation of end reinforcement for aluminum structures, if required.

Sheet up: Belongs on Pipe/Pipe Arch Details sheet.

Scale: Same size as the plan, typically ¼" or larger if there is room.

Draw:

1) Section View – cross-section of pipe or pipe arch and end reinforcement. Toe wall, if required.
2) Elevation View – end elevation of pip or pipe arch and end reinforcement. Toe wall, if required.

Dimension:

1) Elevation View – length of end reinforcement and spacing of connectors

Label:

1) Detail Name
2) End reinforcement
3) Toe wall

5.2.6.5 Structural Plate Pipe or Pipe Arch Toe Wall Elevation

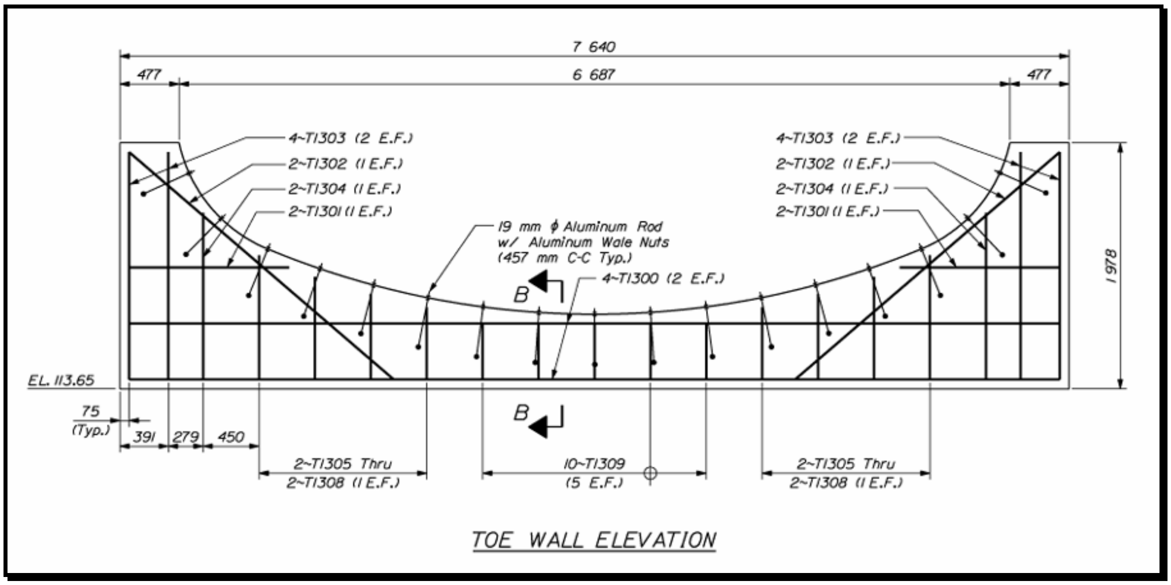


Figure 5-7 Structural Plate Pipe Toe Wall Elevation

Intro: Elevation of reinforced concrete toe wall for aluminum structures, if required.

Sheet up: Belongs on the Pipe/Pipe Arch Details Sheet.

Scale: ½“ but could be larger or smaller depending on the size of the pipe or pipe arch

Draw:

1) Limits of concrete
2) CL Structure
3) Reinforcing steel
4) Aluminum anchor bolts

Dimension:

1) Limits of concrete toe wall
2) Reinforcing steel location

Label:

1) Detail Name

2) Section/Detail Cuts
3) Reinforcing bars
4) Toe wall elevation

5.2.6.6 Structural Plate Pipe or Pipe Arch Toe Wall Section

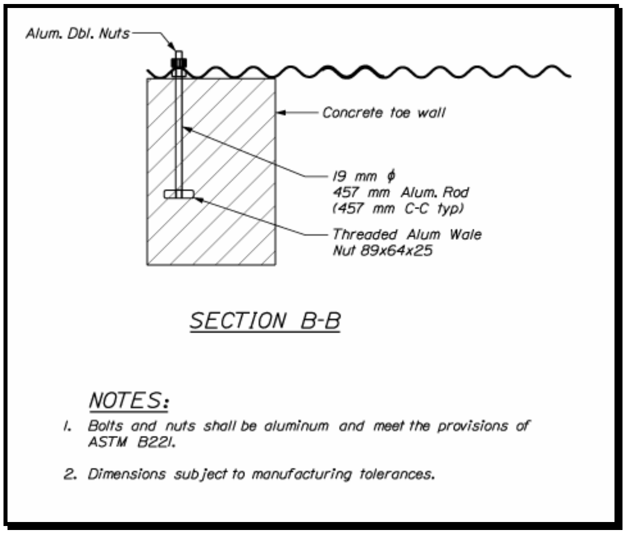


Figure 5-8 Structural Plate Pipe Toe Wall Section

Intro: Cross section through concrete toe wall for aluminum structures, if required.

Sheet up: Belongs on the Pipe/Pipe Arch Details Sheet.

Scale: 1"

Draw:

1) Limits of concrete toe wall (hatch concrete)
2) Corrugated bottom of pipe or pipe arch
3) Anchor bolts

Label:

1) Concrete toe wall
2) Aluminum anchor bolts and nuts

5.2.6.7 Structural Plate Pipe or Pipe Arch Toe Wall Reinforcing Steel Schedule

REINFORCING STEEL SCHEDULE

STRAIGHT BARS							
MARK	QTY.	LENGTH	LOCATION	MARK	QTY.	LENGTH	LOCATION
T1300	8	7480	Toe Wall				
T1301	8	1280	Toe Wall				
T1302	8	2800	Toe Wall				
T1303	16	1820	Toe Wall				
T1304	8	1340	Toe Wall				
T1305	8	990	Toe Wall				
T1306	8	820	Toe Wall				
T1307	8	680	Toe Wall				
T1308	8	580	Toe Wall				
T1309	20	450	Toe Wall				

Figure 5-9 Structural Plate Pipe Reinforcing Steel Schedule

Intro: The reinforcing schedule for concrete toe wall.

Sheet up: Belongs in the upper right of the Pipe/Pipe Arch Details Sheet.

Scale: Not to scale, try ¼". Feel free to draw bars out of scale to help fit them in the schedule.

5.3 Structural Plate Box Culvert

5.3.1 Introduction

These are corrugated metal structures of either steel or aluminum that are used for short-span crossings. Box culverts are used instead of plate pipes and pipe arches when headroom constraints require them.

5.3.2 Prerequisites

You will need the following:

1) Final Horizontal and Vertical Alignments
2) Skew of structure to CL Construction
3) Station where CL of Structure crosses CL Construction
4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
5) Structure size (rise and span)
6) Inlet and Outlet elevations
7) Headwall and wingwall geometry
8) Bedding material type and depth, geotextile usage
9) Toe wall geometry
10) Riprap blanket size, type and location
11) Theoretical streambed elevation
12) Notes

5.3.3 Detailing

Structural Plate Box Culverts require a combination of explicit and performance-based detailing. Earthwork and concrete toe walls are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.3.4 Typical Sheet Names and Contents

5.3.4.1 Steel Box Culvert

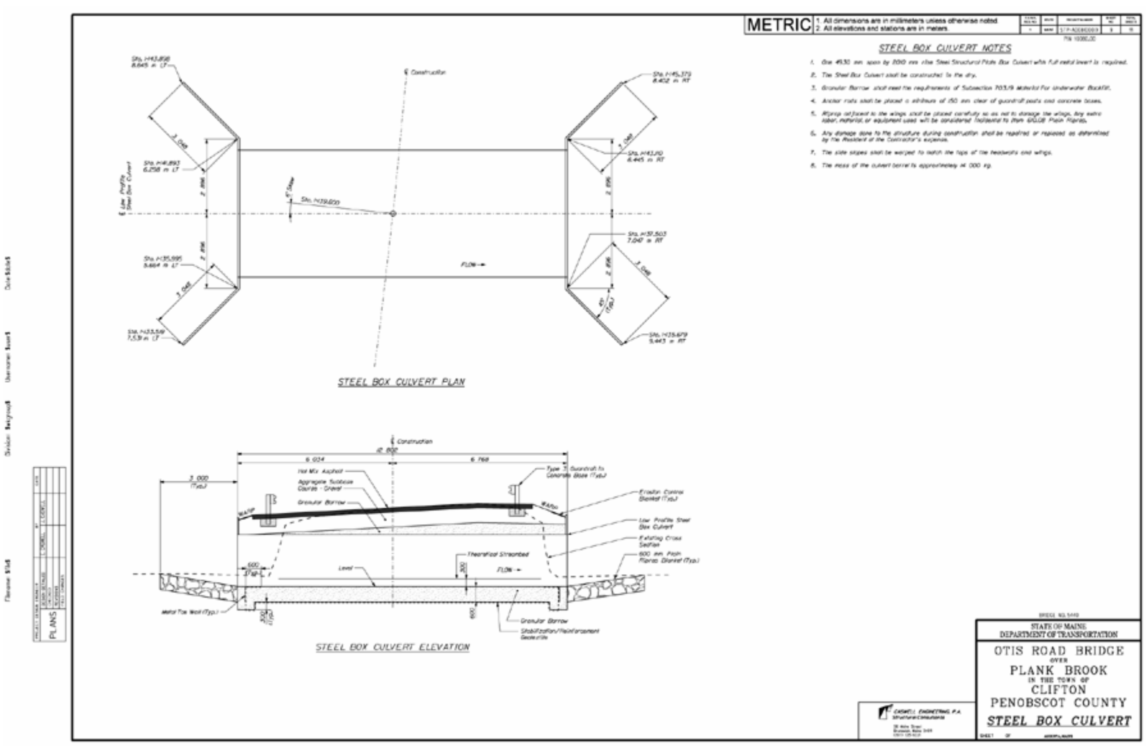


Figure 5-10 Steel Box Culvert Sheet

Will Contain:

1) Steel Box Culvert Plan
2) Steel Box Culvert Elevation
3) Steel Box Culvert Notes

May Contain:

1) Additional Details
2) Additional Notes

5.3.4.2 Steel Box Culvert Details

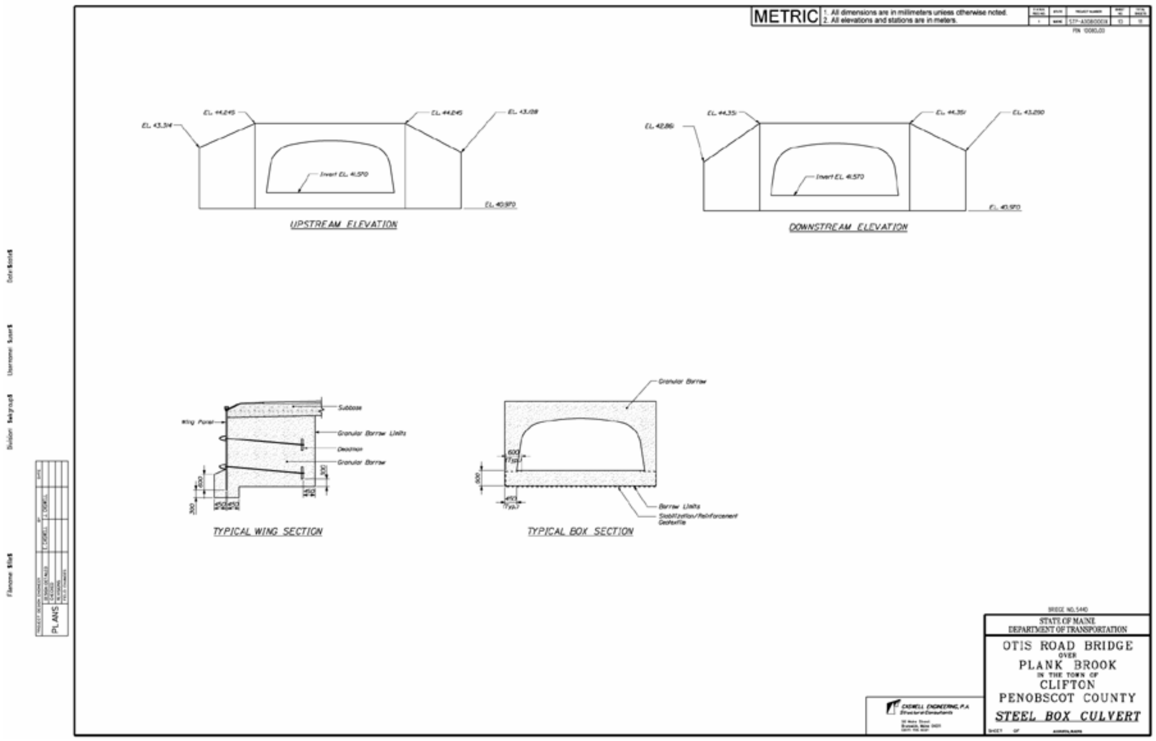


Figure 5-11 Steel Box Culvert Details Sheet

May Contain:

1) Upstream and Downstream Elevations
2) Typical Wall Section
3) Typical Box Culvert Section

5.3.5 Checklists

5.3.5.1 Structural Plate Box Culvert Plan

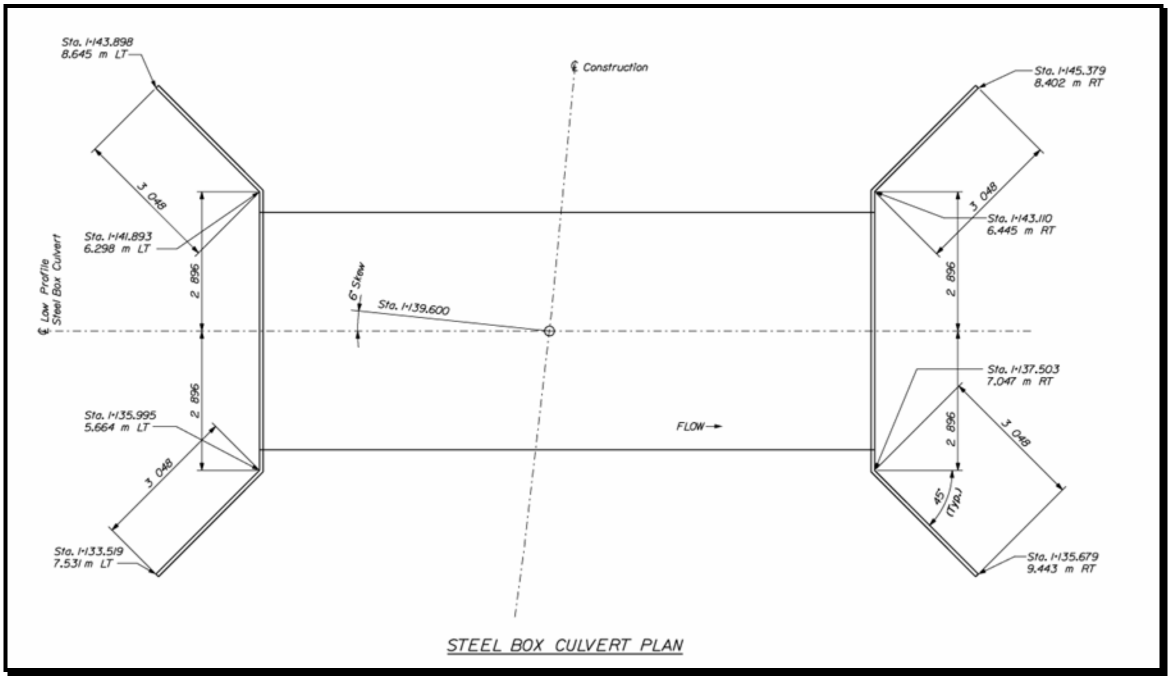


Figure 5-12 Structural Plate Box Culvert Plan

Intro: Top view of box culvert, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the box culvert sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: ¼". (Check sheet up before proceeding. If plan and longitudinal section won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of box culvert
2) Head walls
3) Wing walls
4) Centerline of Construction/Working Line
5) Centerline of Structure
6) Construction joint, if required for stage construction

Dimension:

1) Limits of box culvert, headwalls and wings.
2) Centerline length from the working point to the upstream and downstream ends.
3) Skew angle between CL Structure and line normal to CL Construction/Working Line.

4) Construction joints

Label:

1) Detail Name
2) CL Construction/Working Line
3) CL Structure
4) Station at intersection of CL Construction/Working Line and CL Structure
5) Station and offset at beginning and end of each wing wall.
6) North Arrow
7) Flow Arrow
8) Construction joint

5.3.5.2 Structural Plate Box Culvert Longitudinal Section

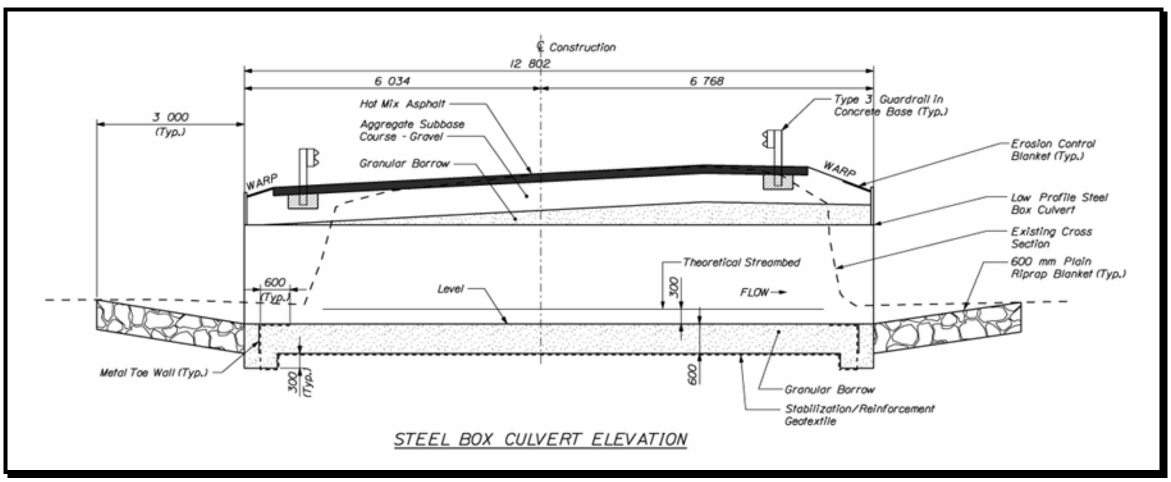


Figure 5-13 Structural Plate Box Culvert Longitudinal Section

Intro: Section cut along the CL of Structure, showing the invert elevations and headwall configurations. View is normal to CL of Structure.

Sheet up: Belongs directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically ¼".

Draw:

1) Limits of structure
2) Centerline of Construction/Working Line
3) Roadway, guardrail and side slopes.
4) Concrete base for guardrail anchorage, if required.
5) Granular borrow cover over structure
6) Bedding material

7) Riprap blanket
8) Riprap side slopes, if required
9) Construction joint, if required for stage construction
10) Toe walls
11) Existing ground
12) Erosion control blanket, if required on side slopes

Dimension:

1) Width of riprap blanket
2) Step in bedding materials at toe wall

Label:

1) Detail Name (Section A-A)
2) Invert elevations
3) Roadway side slopes
4) Guardrail in concrete base
5) Granular borrow cover
6) Bedding material
7) Riprap blanket
8) Toe walls

5.3.5.3 Structural Plate Box Culvert Typical Section

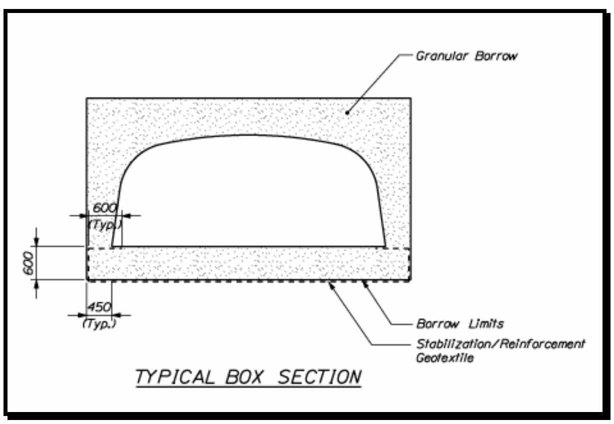


Figure 5-14 Structural Plate Box Culvert Typical Section

Intro: Cross section through box culvert showing limits of granular borrow and bedding requirements.

Sheet up: Belongs to the right of the longitudinal section

Scale: Same size as the plan, typically ¼“ or larger if there is room.

Draw:

1) Limits of box culvert
2) Limits of granular borrow and bedding materials

Dimension:

1) Limits of granular borrow and bedding materials

Label:

1) Detail Name (Section B-B)
2) Granular borrow and bedding materials
3) Granular borrow and structural earth excavation limits

5.3.5.4 Structural Plate Box Culvert Headwall and Wing Elevations

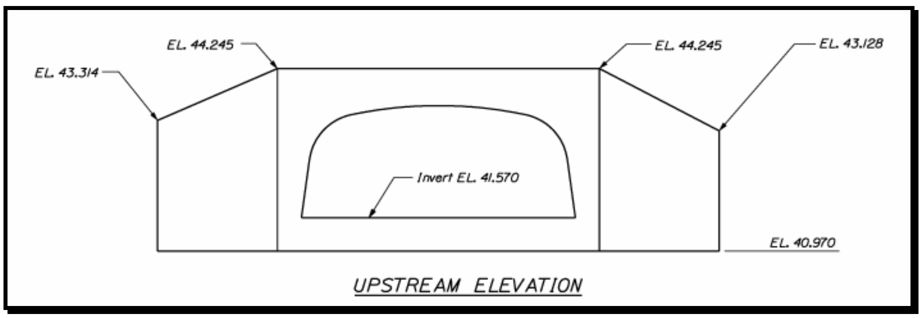


Figure 5-15 Structural Plate Box Culvert Headwall and Wing Elevation

Intro: Separate upstream and downstream elevations showing limits of headwalls and wing walls.

Sheet up: Elevations belong in the upper left of the box culvert details sheet.

Scale: Same size as the plan, typically ¼“ or larger if there is room.

Draw:

1) Limits of box culvert, headwall and wing walls

Label:

1) Detail Names: Upstream Elevation and Downstream Elevation
2) Top of wing and headwall elevations
3) Bottom of wing and headwall elevation
4) Invert elevation

5.3.5.5 Structural Plate Box Culvert Typical Wing Section

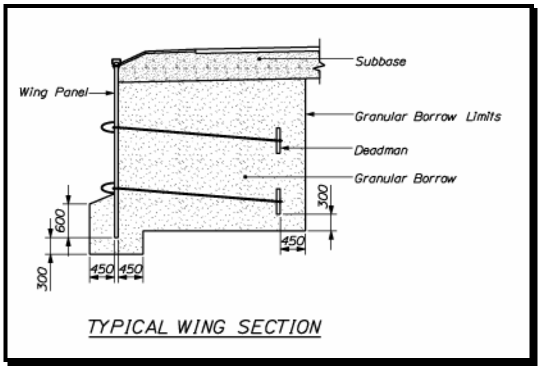


Figure 5-16 Structural Plate Box Culvert Typical Wing Section

Intro: Cross section through structural plate wing showing tie backs and limits of granular borrow.

Sheet up: Belongs in the lower left of the box culvert details sheet.

Scale: Same size as the elevations, typically ¼" or larger if there is room.

Draw:

1) Limits of wing wall panel
2) Wall tie backs and deadmen
3) Limits of granular borrow
4) Roadway berm and side slope

Dimension:

1) Limits of granular borrow with respect to wall panel and deadman anchors

Label:

1) Detail Name
2) Wing panel
3) Granular borrow
4) Granular borrow limits
5) Deadman
6) Roadway subbase

5.4 Structural Plate Arch on CIP Footings

5.4.1 Introduction

These are corrugated metal structures of either steel or aluminum that are used for short-span crossings. Plate Arches are used instead of other metal structures when ledge is present.

5.4.2 Prerequisites

You will need the following:

1) Final Horizontal and Vertical Alignments
2) Skew of structure to CL Construction
3) Station where CL of Structure crosses CL Construction
4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
5) Structure size (rise and span)
6) End Cut of Structure
7) Footing Geometry (width, depth, batter, top elevation)
8) Approximate ledge profile at each footing
9) Theoretical streambed elevation
10) Reinforcing Steel for CIP Footing
11) Notes

5.4.3 Detailing

Structural Plate Arches on CIP Footings require a combination of explicit and performance-based detailing. Earthwork and footings are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.4.4 Typical Sheet Names and Contents

5.4.4.1 ARCH DETAILS

Will Contain:

1) Plan
2) Elevation

May Contain:

1) Notes
2) Section

3) Other Details

5.4.5 Checklists

5.4.5.1 Structural Plate Arch Plan

Intro: Top view of arch, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the arch sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: ¼". (Check sheet up before proceeding. If plan and longitudinal section won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of arch
2) Limits of cast-in-place concrete footings/stub abutments
3) Centerline of Construction/Working Line
4) Centerline of Structure
5) Beveled end cut
6) Construction joint, if required for stage construction

Dimension:

1) Limits of arch. The centerline length from the working point to the upstream and downstream ends. The end cut length measured along the top centerline. Width of opening measured from CL of Structure.
2) Limits of cast-in-place concrete footings/stub abutments. The length of each footing from the working point to the upstream and downstream ends.
3) Skew angle between CL Structure and line normal to CL Construction/Working Line.
4) Skew angle between end of barrel and line normal to CL Structure, if required.
5) Construction joint

Label:

1) Detail Name
2) CL Construction/Working Line
3) CL Structure
4) Station at intersection of CL Construction/Working Line and CL Structure
5) Bevel end cut slope, if end cut is skewed.
6) North Arrow
7) Flow Arrow
8) Construction joint

5.4.5.2 Structural Plate Arch Longitudinal Section

Intro: Section cut along the CL of Structure, showing the springline elevation(s) and end cut configurations. View is normal to CL of Structure.

Sheet up: Belongs directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically ¼".

Draw:

1) Limits of structure
2) Centerline of Construction/Working Line
3) Roadway, guardrail and side slopes.
4) Concrete base for guardrail anchorage, if required.
5) Granular borrow cover over structure
6) Construction joint, if required for stage construction
7) Existing ground

Dimension:

1) Overall length of structure only if it can't be shown in plan view.

Label:

1) Detail Name (Section A-A)
2) Guardrail in concrete base
3) Granular borrow cover
4) Springline elevation(s)
5) Construction joint

5.4.5.3 Structural Plate Arch Typical Section

Intro: Cross section through arch showing limits of granular borrow and cast-in-place concrete footing/stub abutment.

Sheet up: Belongs to the right of the longitudinal section

Scale: Same size as the plan, typically ¼" or larger if there is room.

Draw:

1) Limits of arch
2) Limits of cast-in-place concrete footings/stub abutments
3) Limits of granular borrow and structural earth excavation
4) Existing streambed
5) Footing scour protection

Dimension:

1) Limits of granular borrow

Label:

1) Detail Name (Section B-B)
2) Springline
3) Granular borrow
4) Granular borrow and structural earth excavation limits

5.5 Precast Concrete Box Culvert

5.5.1 Introduction

These are pre-engineered concrete structures that are used for short-span crossings. Concrete Box culverts are used instead of metal structures in corrosive environments or when cover requirements for metal structures can't be met.

5.5.2 Prerequisites

You will need the following:

1) Final Horizontal and Vertical Alignments
2) Skew of structure to CL Construction
3) Station where CL of Structure crosses CL Construction
4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
5) Structure size (rise and span)
6) Inlet and Outlet elevations
7) Mitre to slope or headwall/wingwall geometry
8) Construction joint location for staged construction
9) Guardrail/curb geometry (elevation of top of curb if curb to be placed on box)
10) Bedding material type and depth, geotextile usage
11) Toe wall geometry
12) Riprap blanket size, type and location
13) Theoretical streambed elevation
14) If there are CIP Curbs: Reinforcing steel design
15) Notes

5.5.3 Detailing

Concrete Box Culvers require a combination of explicit and performance-based detailing. Earthwork and curbs are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.5.4 Typical Sheet Names and Contents

5.5.4.1 BOX CULVERT DETAILS

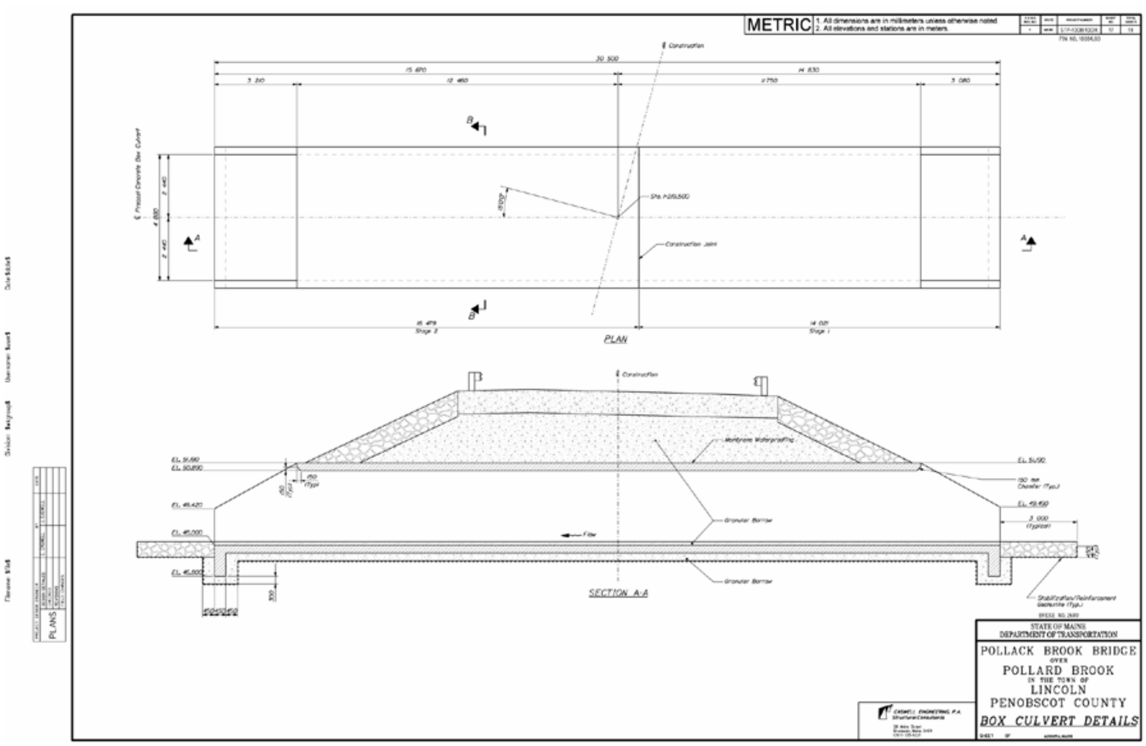


Figure 5-17 Box Culvert Details

Will Contain:

1) Plan
2) Elevation

May Contain:

1) Notes
2) Other Details

5.5.5 Standard Notes

5.5.5.1 Precast Concrete Box Notes

(The following note is used if applicable.)

1) The precast units shall be designed to carry construction loadings with a minimum fill cover of 1'-6" on top of the units.
2) 2. The construction, handling, and assembly of the precast units shall be in accordance with Special Provision Section 534 Precast Structural Concrete, and with the Manufacturer's Specifications as applicable.

3) Install membrane waterproofing over the top and to 1 foot down the exterior sides of the precast units.

5.5.6 Checklists

5.5.6.1 Precast Concrete Box Culvert Plan

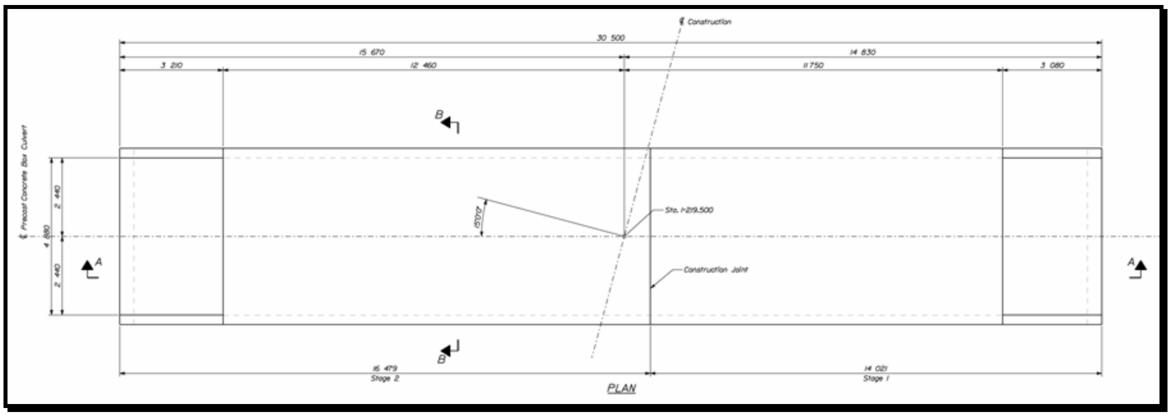


Figure 5-18 Precast Concrete Box Culvert Plan

Intro: Top view of box culvert, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the box culvert sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: ¼". (Check sheet up before proceeding. If plan and longitudinal section won't fit above and below at ¼", try 3/16" scale.)

Draw:

1) Limits of box culvert
2) Centerline of Construction/Working Line
3) Centerline of Structure
4) Beveled end cut
5) Construction joint, if required for stage construction
6) Toe wall, if required

Dimension:

1) Limits of box culvert. The bottom centerline length from the working point to the upstream and downstream ends. The top centerline length and end cut length for mitered to slope structures. Width of box culvert.
2) Skew angle between CL Structure and line normal to CL Construction/Working Line.
3) Skew angle between end of barrel and line normal to CL Structure, if required.
4) Construction joint

Label:

1) Detail Name
2) CL Construction/Working Line
3) CL Structure
4) Station at intersection of CL Construction/Working Line and CL Structure
5) North Arrow
6) Flow Arrow
7) Construction joint

5.5.6.2 Precast Concrete Box Culvert Longitudinal Section

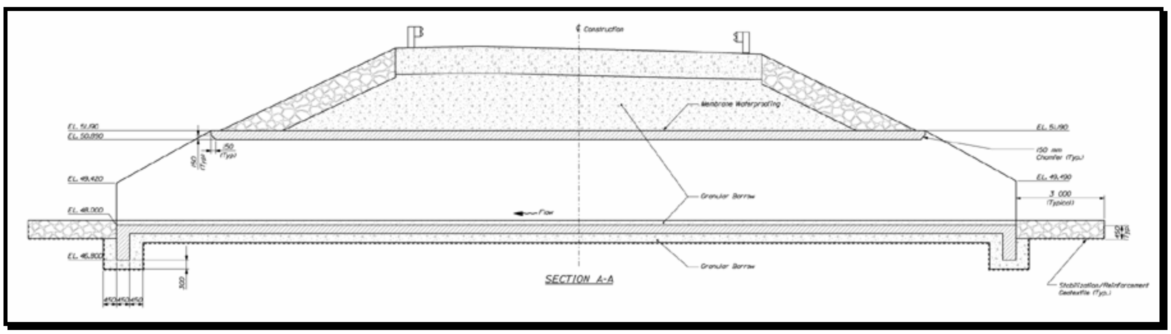


Figure 5-19 Precast Concrete Box Culvert Longitudinal Section

Intro: Section cut along the CL of Structure, showing the invert elevations and end cut configurations. View is normal to CL of Structure.

Sheet up: Belongs directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically ¼".

Draw:

1) Limits of box culvert
2) Centerline of Construction/Working Line
3) Roadway, guardrail and side slopes.
4) Concrete base for guardrail anchorage, if required.
5) Granular borrow cover over structure
6) Membrane Waterproofing
7) Bedding material
8) Riprap blanket
9) Riprap side slopes, if required
10) Existing ground
11) Construction joint, if required for stage construction

12) Toe walls

Dimension:

1) Bottom step cut
2) Width of riprap blanket
3) Step in bedding materials at toe wall
4) Toe wall
5) Headwall chamfer

Label:

1) Detail Name (Section A-A)
2) Invert elevations
3) End bevel slopes.
4) Guardrail in concrete base, if required
5) Bedding materials
6) Granular borrow cover
7) Riprap blanket
8) Membrane waterproofing
9) Toe walls
10) Headwall chamfer

5.5.6.3 Precast Concrete Box Culvert Typical Section

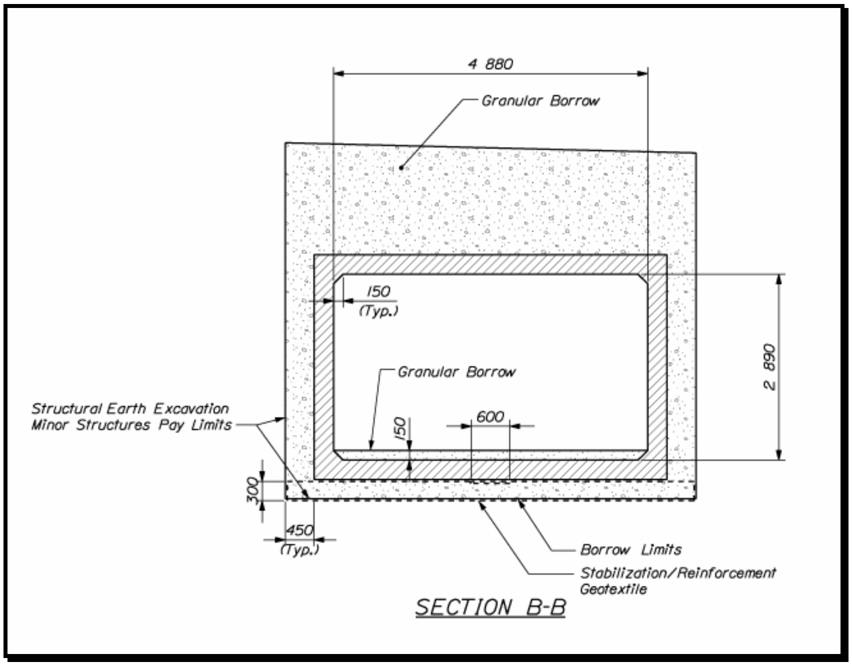


Figure 5-20 Precast Concrete Box Culvert Typical Section

Intro: Cross section through box culvert showing limits of granular borrow and bedding requirements.

Sheet up: If it fits place it to the right of the longitudinal section. on box culvert details sheet.

Scale: Same size as the plan, typically ¼“ or larger if there is room.

Draw:

1) Limits of box culvert
2) Limits of granular borrow, structural earth excavation and bedding materials

Dimension:

1) Limits of granular borrow and bedding materials
2) Upper corner haunches

Label:

1) Detail Name (Section B-B)
2) Granular borrow and bedding materials
3) Granular borrow and structural earth excavation limits

5.5.6.4 Precast Concrete Box Culvert Wing Elevations

Intro: Use when the box culvert has headwalls and wings instead of mitered to slope end cut. Separate upstream and downstream elevations showing limits of headwalls and wing walls.

Sheet up: Elevations belong in the upper left of the box culvert details sheet.

Scale: Same size as the plan, typically ¼" or larger if there is room.

Draw:

1) Limits of box culvert, headwall and wing walls

Label:

1) Detail Names: Upstream Elevation and Downstream Elevation
2) Top of wing and headwall elevations
3) Bottom of wing and headwall elevation
4) Invert elevation

5.5.6.5 Precast Concrete Box Culvert Typical Wing Section

Intro: Use when the box culvert has headwalls and wings instead of mitered to slope end cut. Cross section through precast wing showing limits of granular borrow.

Sheet up: Belongs in the lower left of the box culvert details sheet.

Scale: Same size as the elevations, typically ¼ " or larger if there is room.

Draw:

1) Limits of precast wing wall panel
2) Limits of granular borrow
3) Roadway berm and side slope

Dimension:

1) Limits of granular borrow with respect to wall panel

Label:

1) Detail Name
2) Wing wall panel
3) Granular borrow
4) Granular borrow limits
5) Roadway subbase

5.6 Precast Concrete Arch or Rigid Frame on CIP Footing

5.6.1 Introduction

These are pre-engineered concrete structures that are used for short-span crossings. Concrete Arches or Rigid Frames are used instead of other buried structures in corrosive environments where ledge is present.

5.6.2 Prerequisites

You will need the following:

1) Final Horizontal and Vertical Alignments
2) Skew of structure to CL Construction
3) Station where CL of Structure crosses CL Construction
4) Final Roadway Design (travel way and shoulder width, superelevation, side slopes, etc.)
5) Structure size (rise and span)
6) Headwall/Wingwall Geometry
7) Footing Geometry (width, depth, batter, top elevation)
8) Guardrail/curb geometry (elevation of top of curb if curb to be placed on structure)
9) Approximate ledge profile at each footing
10) Theoretical streambed elevation
11) Reinforcing Steel Design for CIP Footings
12) If there are CIP Curbs: Reinforcing steel design
13) Springing Line Elevation
14) Notes

5.6.3 Detailing

Precast Arches on CIP Footings require a combination of explicit and performance-based detailing. Earthwork and footings are detailed explicitly, while the structure itself is drawn diagrammatically. The Fabricator of the structure and the Contractor need to be considered equally when detailing.

5.6.4 Typical Sheet Names and Contents

5.6.4.1 ARCH / RIGID FRAME DETAILS

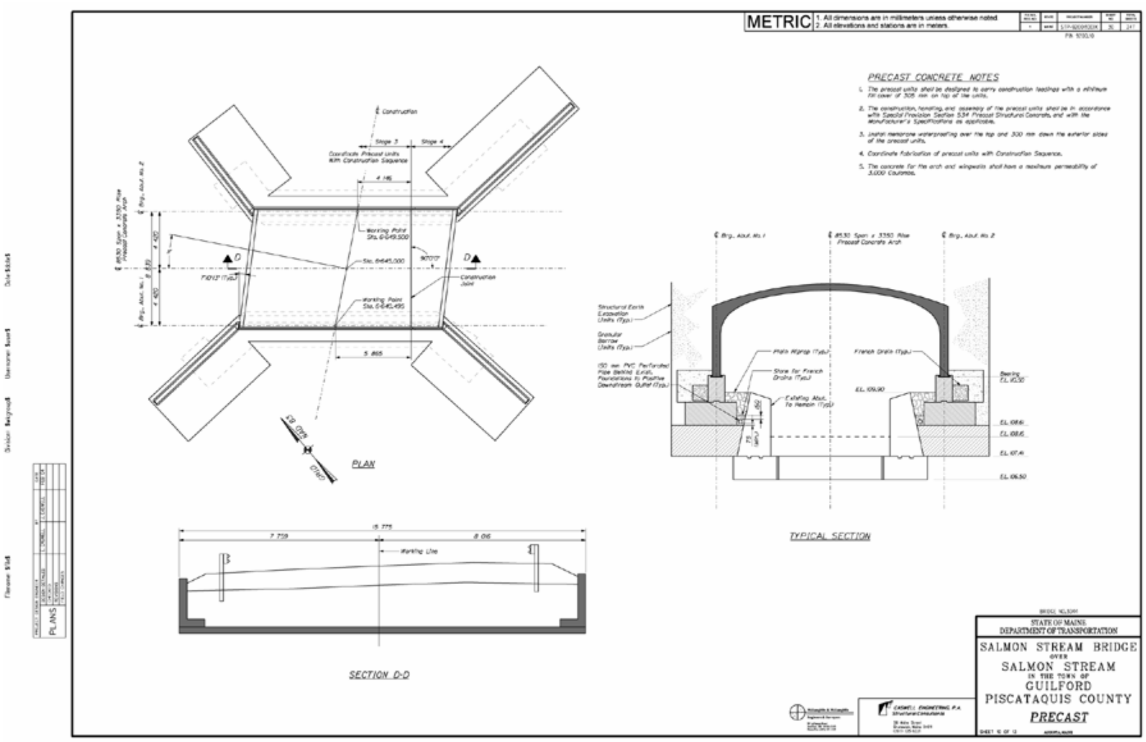


Figure 5-21 Arch / Rigid Frame Details

Will Contain:

1) Plan
2) Elevation

May Contain:

1) Section
2) Notes
3) Other Details

5.6.4.2 ARCH / RIGID FRAME ELEVATIONS

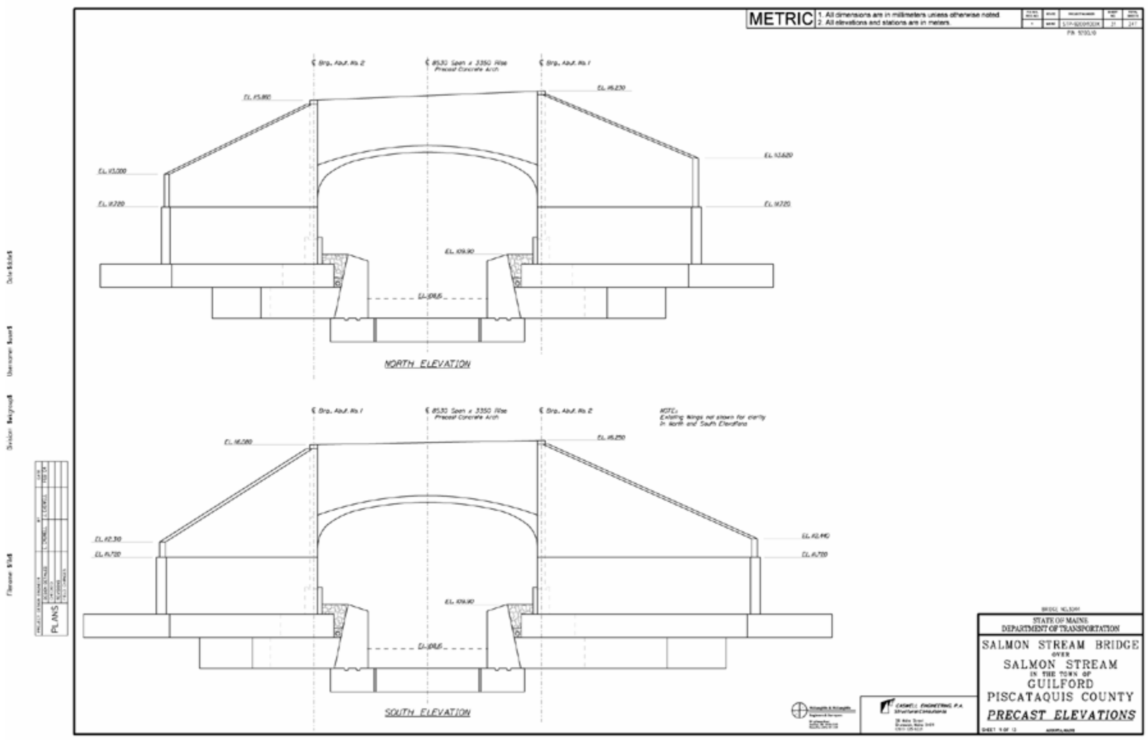


Figure 5-22 Arch / Rigid Frame Elevations

Will Contain:

1) Upstream Elevation
2) Downstream Elevation

May Contain:

1) Notes
2) Other Details

5.6.4.3 WING DETAILS

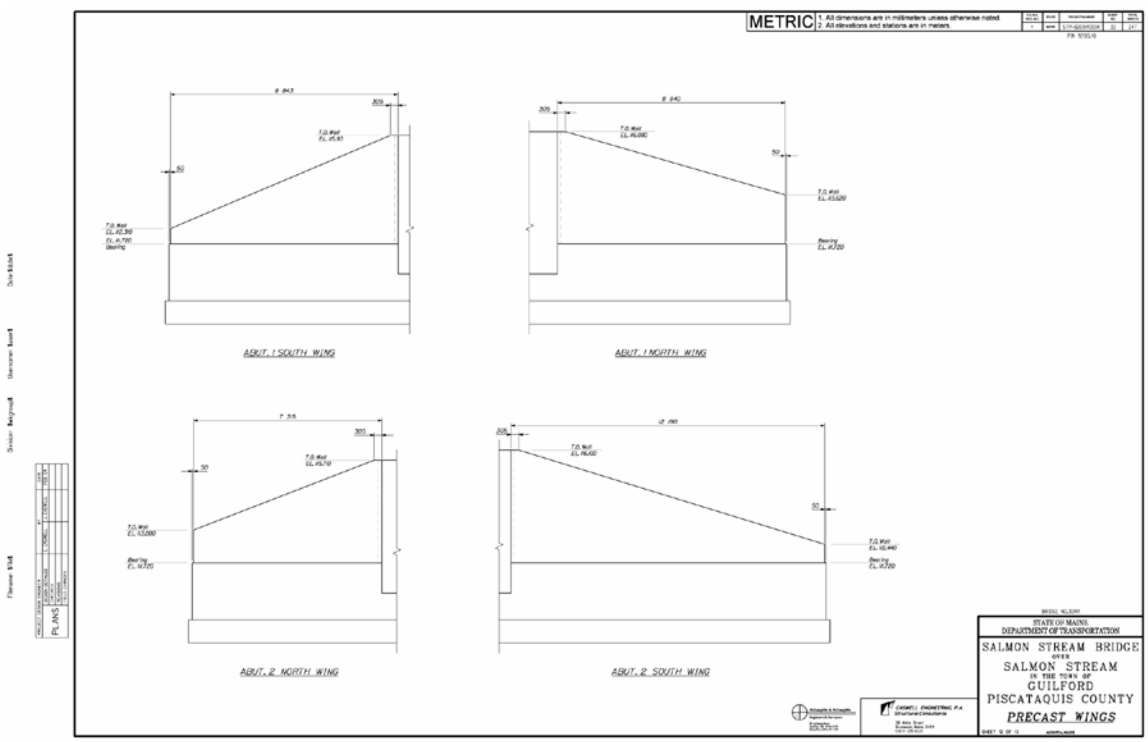


Figure 5-23 Wing Details

Will Contain:

1) Wing Elevations

May Contain:

1) Wing Plans
2) Notes
3) Other Details

5.6.5 Standard Notes

1.1.1.1 Precast Concrete Arch Notes

(The following note is used if applicable.)

1) The precast units shall be designed to carry construction loadings with a minimum fill cover of 1'-6" on top of the units.

2) 2. The construction, handling, and assembly of the precast units shall be in accordance with Special Provision Section 534 Precast Structural Concrete, and with the Manufacturer's Specifications as applicable.

Install membrane waterproofing over the top and to 1 foot down the exterior sides of the precast units.

5.6.6 Checklists

5.6.6.1 Precast Concrete Arch or Rigid Frame Plan

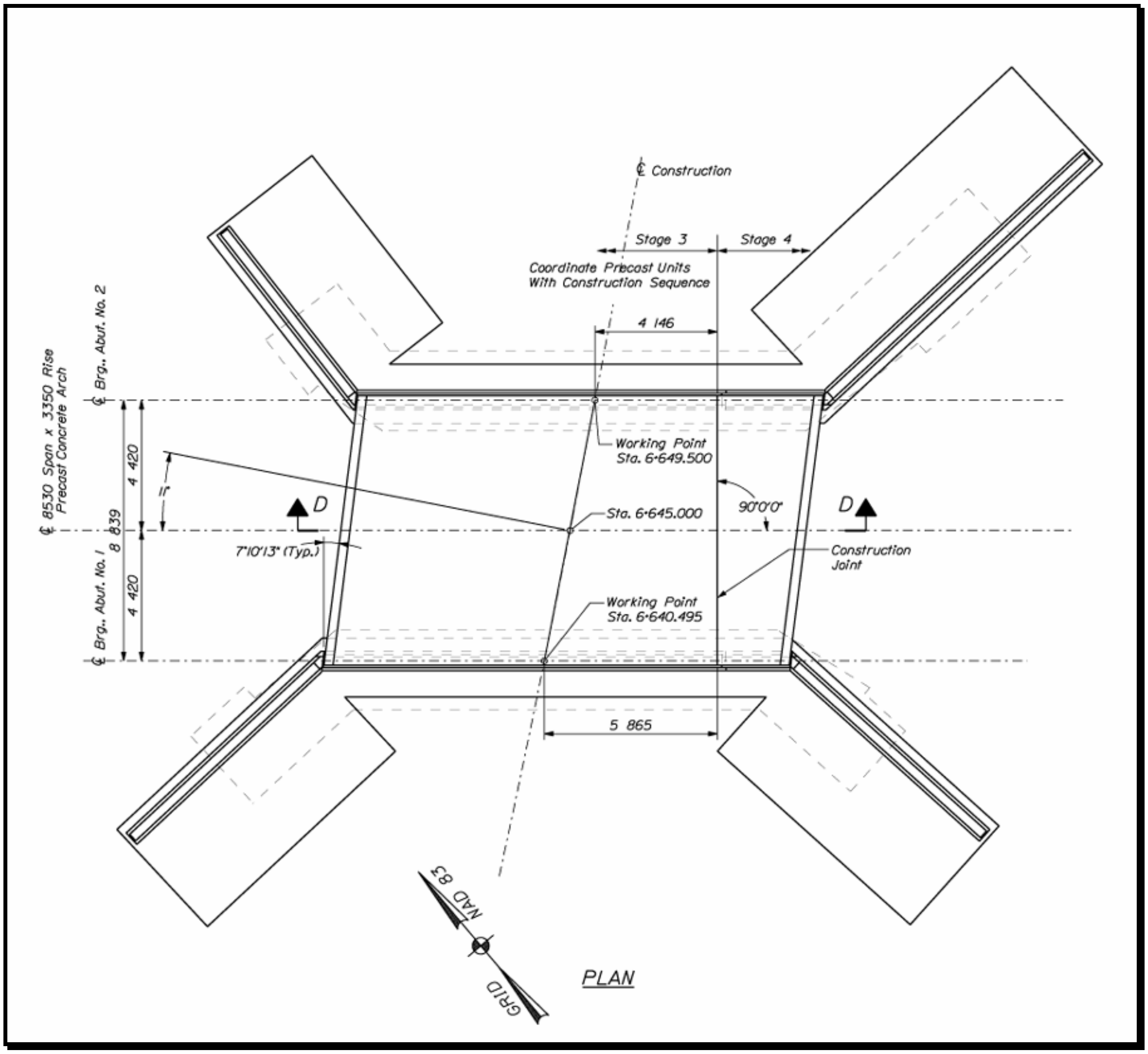


Figure 5-24 Precast Concrete Arch Plan

Intro: Top view of arch or rigid frame, showing the relationship to the working lines.

Sheet up: Belongs in the upper left of the arch or rigid frame sheet, directly above the longitudinal section, with the centerlines aligned.

Scale: ¼“. (Check sheet up before proceeding. If plan and longitudinal section won’t fit above and below at ¼“, try 3/16” scale.)

Draw:

1) Limits of arch or rigid frame

2) Limits of wing walls

3) Limits of cast-in-place footings/stub abutments

4) Centerline of Construction/Working Line
5) Centerline of Structure
6) Construction joint, if required for stage construction

Dimension:

1) Limits of arch or rigid frame. The centerline length from the working point to the upstream and downstream ends. Width of opening measured from CL of Structure.
2) Skew angle between CL Structure and line normal to CL Construction/Working Line.
3) Skew angle between end of barrel and line normal to CL Structure, if required.
4) Construction joint

Label:

1) Detail Name
2) CL Construction/Working Line
3) CL Structure
4) Station at intersection of CL Construction/Working Line and CL Structure
5) North Arrow
6) Flow Arrow
7) Construction joint

5.6.6.2 Precast Concrete Arch or Rigid Frame Section

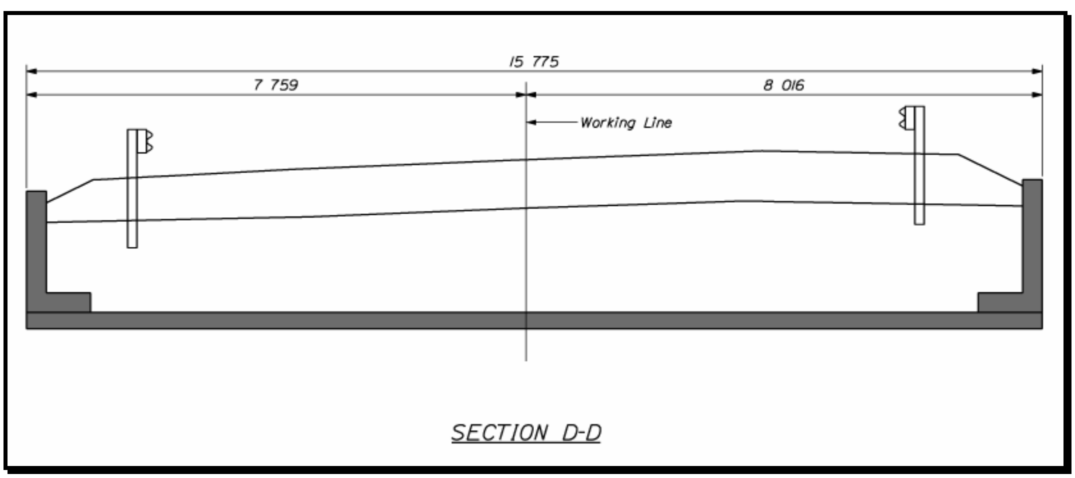


Figure 5-25 Precast Concrete Arch Section

Intro: Section cut along the CL of Structure, showing the springline elevation(s) and headwall configurations. View is normal to CL of Structure.

Sheet up: Belongs directly below the Plan, with the centerlines aligned.

Scale: Same size as the plan, typically ¼ “.

Draw:

1) Limits of structure
2) Centerline of Construction/Working Line
3) Roadway, guardrail and side slopes.
4) Concrete base for guardrail anchorage, if required.
5) Granular borrow cover over structure
6) Construction joint, if required for stage construction
7) Existing ground
8) Erosion control blanket, if required on side slopes.

Dimension:

1) Overall length of structure only if it can't be shown in plan view.

Label:

1) Detail Name (Section A-A)
2) Guardrail in concrete base
3) Granular borrow cover
4) Springline elevation(s)
5) Construction joint

5.6.6.3 Precast Concrete Arch or Rigid Frame Typical Section

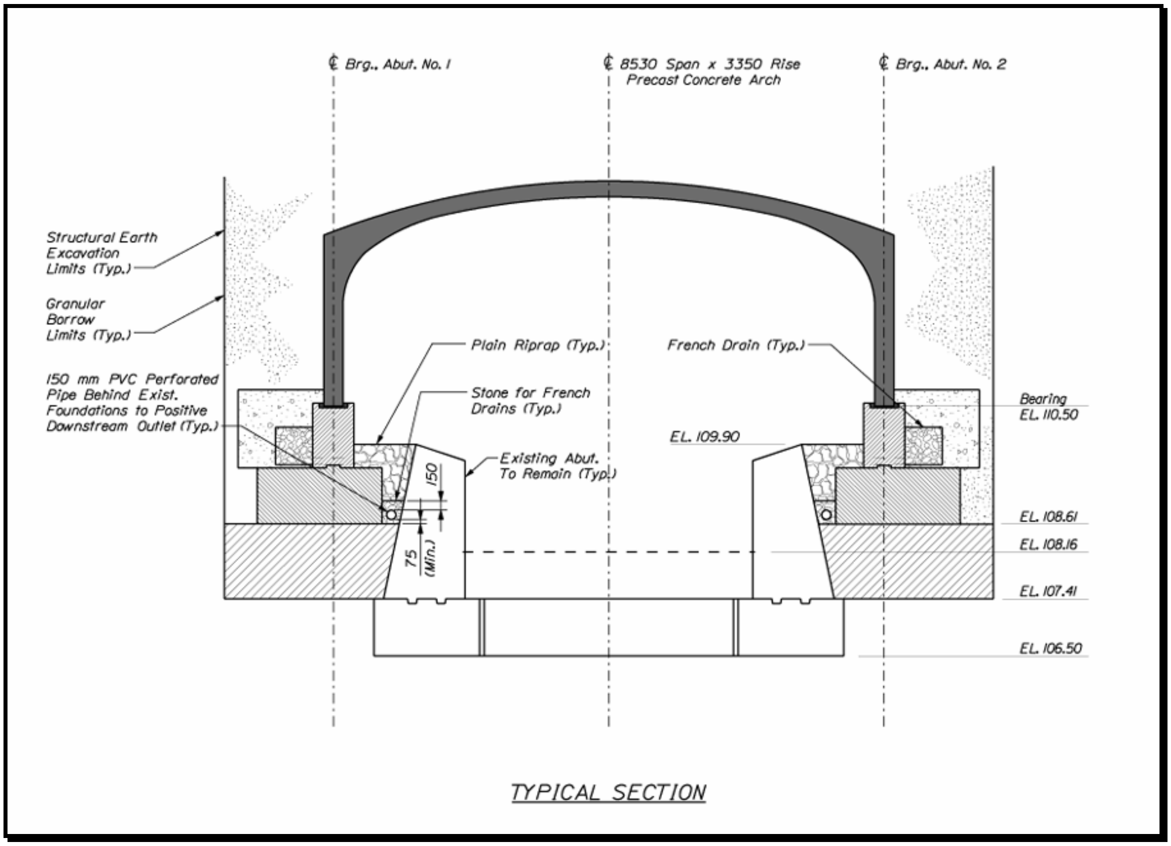


Figure 5-26 Precast Concrete Arch Typical Section

Intro: Cross section through precast arch or rigid frame showing limits of granular borrow and cast-in-place concrete footing/stub abutment.

Sheet up: Belongs to the right of the longitudinal section

Scale: Same size as the plan, typically ¼ " or larger if there is room.

Draw:

1) Limits of precast arch or rigid frame
2) Limits of cast-in-place concrete footings/stub abutments
3) Limits of granular borrow and structural earth excavation
4) French drain
5) Existing streambed
6) Footing scour protection

Dimension:

1) Limits of granular borrow

Label:

1) Detail Name (Section B-B)
2) Precast arch or rigid frame bearing elevation
3) Granular borrow
4) Granular borrow and structural earth excavation limits

5.6.6.4 Precast Concrete Arch or Rigid Frame Headwall and Wing Elevations

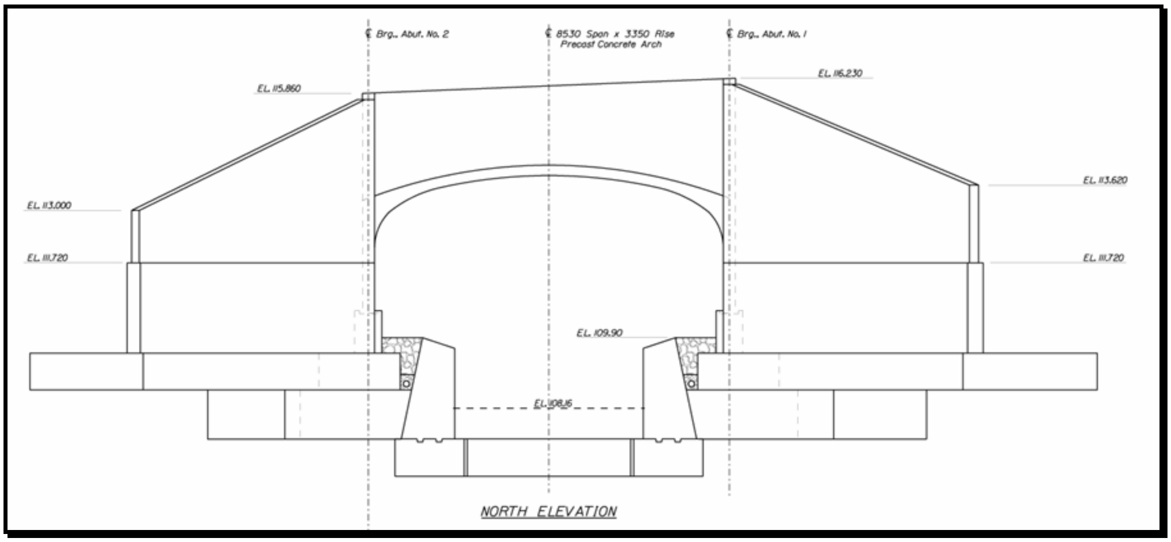


Figure 5-27 Precast Concrete Arch End Elevation

Intro: Separate upstream and downstream elevations showing limits of headwalls and wing walls. Separate elevations of each wing wall may be necessary to provide all wing dimensions.

Sheet up: Elevations belong in the upper left of the arch or rigid frame details sheet.

Scale: Same size as the plan, typically ¼" or larger if there is room.

Draw:

1) Limits of arch or rigid frame, headwall and wing walls
2) Limit of cast-in-place concrete footings/stub abutments

Label:

1) Detail Names: Upstream Elevation and Downstream Elevation
2) Top of wing and headwall elevations
3) Bottom of precast wing elevation

CHAPTER 6 REHABILITATION

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6.2 Wearing Surface Replacement

6.2.1 Introduction

Wearing Surface Replacement projects involve removal and replacement of existing asphalt or concrete wearing surfaces and the rehabilitation of other bridge features such as deck slabs, joints, curbs/sidewalks, bridge rails, end posts and approach guardrail, as required. The items to be rehabilitated vary from project to project.

6.2.2 Typical Sheet Names and Contents

6.2.2.1 Title Sheet

↳ Refer to Chapter 7 for more information.

6.2.2.2 Estimated Quantities

↳ Refer to Chapter 7 for more information.

6.2.2.3 General Plan

6.2.2.4 Details

6.2.2.5 Staged Construction

↳ Refer to Chapter 7 for more information.

6.2.2.6 Reinforcing Steel Schedule (if applicable)

↳ Refer to Chapter 8 for more information

6.2.3 Detail List

Wearing Surface detailing may include the following:

1) General Construction Notes
2) Staged Construction Scheme
3) Plan
4) Transverse Section
5) Bridge Rail and Guardrail Modification Details
6) Aluminum Bridge Rail Splice Modification Details
7) Joint Rehab Details
8) Other Rehab Details (make sure to have geometry checked before designing any reinforcing steel req'd)

6.2.4 Prerequisites

1) Existing plans
2) Existing wearing surface thickness
3) Proposed Wearing Surface and Membrane Thicknesses
4) Scope of work listing the items to be rehabilitated. If answer to any of the following questions is yes, detailer must get a comprehensive rehab/replacement scheme from the designer.
    a) End post to be replaced?
    b) Approach Rail to be reset or replaced?
    c) Bridge Rail to be reset or replaced?
    d) Joint Armor to be rehabbed?
    e) Seals to be replaced?
    f) Aluminum Bridge Rail Splices to be modified?
    g) Shoulders to be rehabilitated/widened?

6.2.5 Detailing

Include a legend for Existing Concrete to Remain, New Concrete, Existing Concrete to be removed and Existing Granite to remain.

6.2.6 Checklists

6.2.6.1 Plan

Intro: Bare bones general plan showing bridge and abbreviated approaches.

Sheet up: Belongs in the upper left of the General Plan sheet.

Scale: 1"=25'

Draw:

1) Centerline of Construction
2) Centerline of Bearings Abutments and Piers
3) Limits of wearing surface removal and replacement
4) Curbs/sidewalks
5) Approach guardrail
6) Bridge drains

Dimension:

1) Deck width from CL of Construction
2) Skew angle between CL Abutment/Pier and line normal to CL Construction

3) Curbs/sidewalks widths
4) CL of bearings
5) Location of pavement transition at each approach

Label:

1) Detail Name (Plan)
2) North Arrow
3) Traffic flow arrows
4) Flow Arrow, if water crossing
5) CL Roadway or Railroad if grade crossing
6) Fixed or expansion bearings
7) Bar scale
8) Pavement transition
9) Label rehabilitation work (i.e. Remove, modify and reset 262.5 LF of existing guardrail; Retrofit and seal the deck joints at the piers; Modify sidewalk to provide handicap access…)
10) Bridge drains

6.2.6.2 Transverse Section

Intro: Transverse bridge section shows existing conditions on left side and proposed rehabilitations on right.

Sheet up: Belongs directly below the plan on the General Plan sheet.

Scale: ¼" or larger if there is room

Draw:

1) CL Construction/Working Line
2) Superstructure, including deck, girders or box beams
3) Wearing surface
4) Curbs/sidewalks
5) Bridge rail
6) Bridge drains
7) Utilities on bridge

Dimension:

1) Deck width from CL of Construction

Label:

1) Detail Name (Transverse Section)
2) Existing and Proposed

3) Cross slope
4) Remove existing wearing surface and membrane waterproofing
5) Install 3" hot mix asphalt and ¼" membrane waterproofing
6) Rehabilitate structural concrete slab as directed by Resident
7) Repairs to curbs/sidewalk, if required
8) Repairs to bridge rail, if required

6.2.6.3 Approach Pavement Transition Detail

Intro: Consists of two cross-sectional details showing the limits of pavement removal and replacement, respectively, at the roadway/bridge deck transition. The second detail shows how to accommodate the increased pavement thickness on the bridge.

Sheet up: If there is room, locate to the right of the transverse section on the general plan sheet. Otherwise it can go on a detail sheet.

Scale: 1½"

Draw:

1) Removal Detail (Existing approach pavement, existing wearing surface on bridge, joint at end of bridge deck, hatch limits of pavement removal on approach)
2) Replacement Detail (Similar to removal detail except show limits of new pavement)

Dimension:

1) Removal Detail (Depth of pavement removal)
2) Replacement Detail (Depth of proposed pavement)

Label:

1) Detail Name
2) Removal Detail (Existing approach pavement, limits of approach pavement removal, end of bridge deck, top of existing wearing surface on bridge)
3) Replacement Detail (Existing approach pavement, limits of proposed pavement, end of bridge deck, top of proposed pavement on bridge, existing wearing surface on bridge, note to see joint modification detail)

6.3 Deck Replacement

6.3.1 Introduction

Deck Replacement projects involve removal and replacement of the concrete bridge deck, curbs/sidewalks and bridge rails and the rehabilitation of other features such as bridge joints, girder bearings and approach guardrail, as required. The items to be rehabilitated vary from project to project.

6.3.2 Typical Sheet Names and Contents

6.3.2.1 Required

Title Sheet

Estimated Quantities

General Plan

Staged Construction

Structural Steel

Superstructure

Superstructure Details

Reinforcing Steel

6.3.2.2 Other sheets if required

Abutments

Piers

End Posts

Bridge Bearings.

Expansion Devices

6.3.3 Prerequisites

The following information needs to be gathered to detail plans:

1) Structural Steel Design
2) Transverse Section Design
3) Reinforcing Steel Design
4) Other rehab plan and details (make sure to have geometry checked before detailing any reinforcing steel)

5) Scope of work listing the items to be rehabilitated. If answer to any of the following questions is yes, detailer must get comprehensive rehab/replacement scheme from the designer.
   A. Joints to be replaced?
   B. Bridge bearings to be replaced?
   C. Abutments or piers to be modified for new joints and bearings?
   D. End posts to be replaced or added?
   E. Approach rail to be reset or replaced?
   F. Shoulder to be rehabbed/widened?
6) Staged Construction Scheme
7) Complete list of pay items to be estimated
8) Complete general construction notes
9) Existing plans
10) Existing slab and wearing surface thicknesses.
11) Proposed slab and wearing surface thicknesses
12) Proposed bridge rail

6.3.4 Detailing

Include a legend for New Concrete, Existing Concrete to be removed and Existing Concrete to remain.

6.3.5 Checklists

6.3.5.1 General Plan

Refer to plan checklist, Chapter 2.

6.3.5.2 Superstructure Plan

Refer to superstructure plan checklist, Chapter 4.

6.3.5.3 Transverse Section

Similar to bridge replacement project except steel girders are existing. Refer to Transverse Section checklist in Chapter 4.

6.3.5.4 End of Slab Section

Similar to bridge replacement project except abutment is existing. Refer to End of Slab Section checklist in Chapter 4. Differences may include modifications to the existing abutment for new joint armor or slab over backwall condition.

6.3.5.5 Slab Haunch and Blocking Detail

Refer to Slab Haunch and Blocking Detail Section checklist in Chapter 4.

6.3.5.6 Bottom of Slab Elevation Layout Plan

Refer to Bottom of Slab Elevation Layout Plan checklist, Chapter 4.

6.3.5.7 Existing Framing Plan

Similar to bridge replacement project except girders, diaphragms and bearing stiffeners are existing. Refer to Framing Plan checklist, Chapter 4.

6.3.5.8 Beam Elevation and Stud Layout

Required if adding or replacing shear studs, cover plates or bearing stiffeners. Refer to Beam Elevation and Stud Layout checklist in Chapter 4.

6.4 Invert Lining

6.4.1 Introduction

Invert lining projects are typically rehabilitations of the bottoms of pipes and pipe arches after they have corroded.

6.4.2 Prerequisites

You will need:

1) Size and length of existing structure
2) Relationship of structure to CL Road (length and skew)
3) Invert lining scheme, including:
    a) Thickness
    b) Height
    c) End Conditions
4) Reinforcing scheme
5) Design/Modifications to facilitate fish passage
6) Notes

6.4.3 Detailing

Invert Linings require explicit rather than performance-based details. The Contractor is the main client to consider when detailing.

6.4.4 Typical Sheet Names and Contents

6.4.4.1 Invert Lining, Pipe, etc.

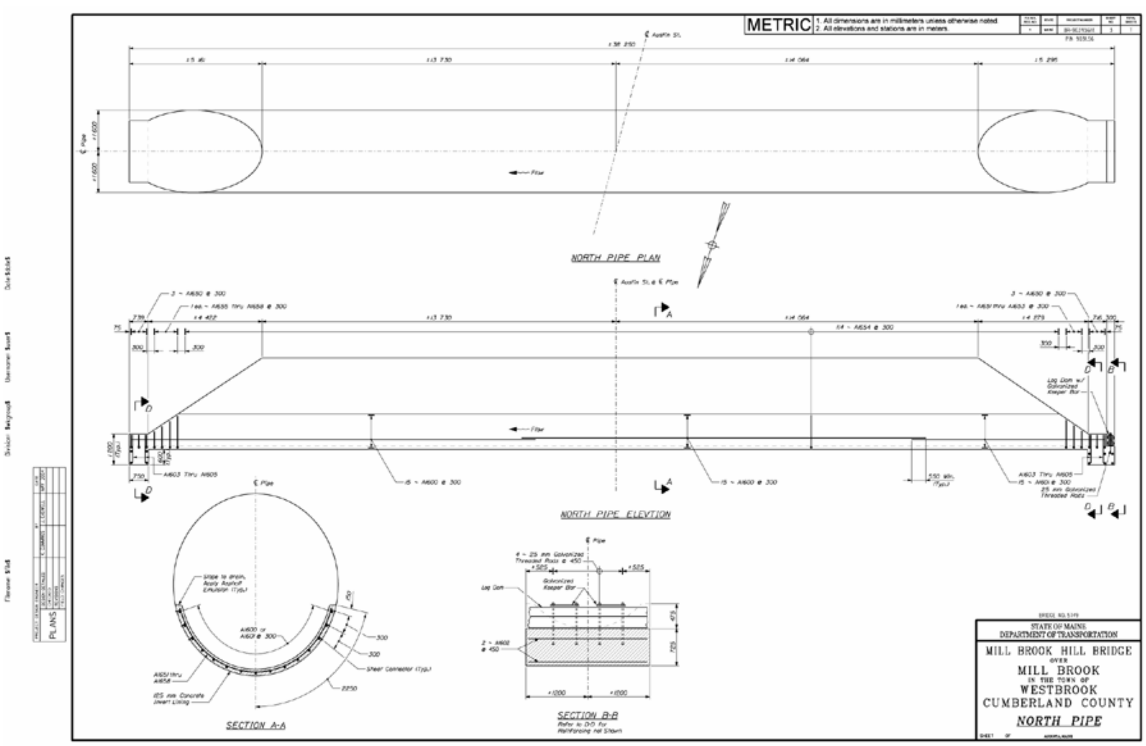

Figure 6-1 Invert Lining Sheet

Will Contain:

1) Invert lining Plan
2) Invert Lining Elevation
3) Invert Lining Section

May Contain:

1) Other Details
2) Notes

6.4.5 Standard Notes

6.4.6 Checklists

6.4.6.1 Invert Lining Plan

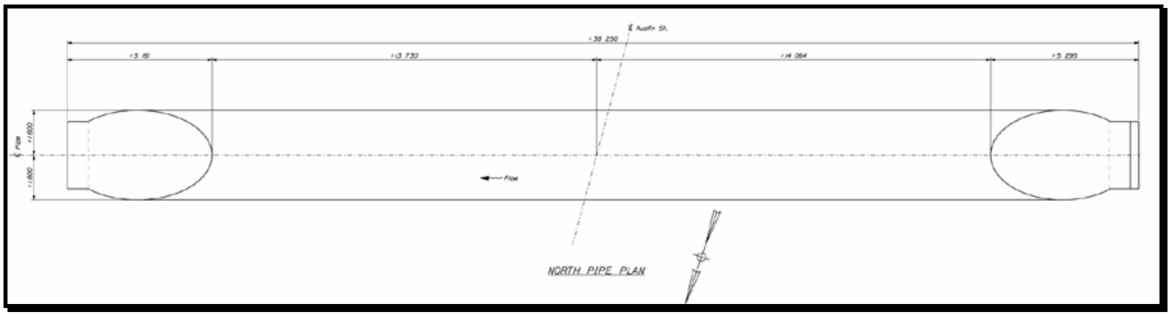

Figure 6-2 Invert Lining Plan

Intro: the invert lining plan shows the existing pipe and limits of the invert lining.

Sheet up: belongs on invert lining sheet, upper left, directly above elevation with working points aligned

Scale: ¼” = 1’-0”

Draw:

1) CL Road
2) CL Structure
3) Existing Structure
4) Invert lining as it impacts the plan

Dimension:

1) Approximate structure length and location
2) Approximate structure size
3) Approximate end bevel
4) Approximate skew

Label:

1) Detail Name
2) CL Road
3) CL Pipe
4) Flow
5) North

6.4.6.2 Invert Lining Elevation

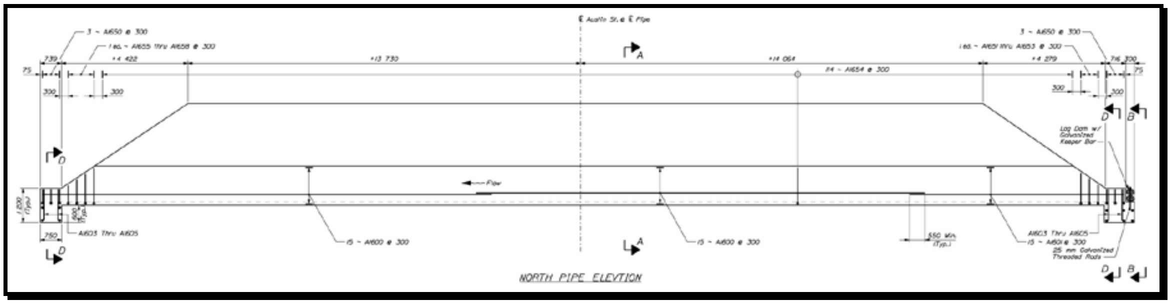

Figure 6-3 Invert Lining Elevation

Intro: the invert lining elevation shows the vertical limits of the lining and the reinforcing steel

Sheet up: belongs on invert lining sheet, directly below plan with working points aligned

Scale: ¼”=1’-0”

Draw:

1) CL Road
2) Existing Structure
3) Proposed limits of invert lining
4) Reinforcing Steel

Dimension:

1) Approximate Length of pipe
2) Invert Lining
3) Reinforcing Steel

Label:

1) Detail Name
2) CL Road
3) Flow
4) Section Cuts

6.4.6.3 Invert Lining Section

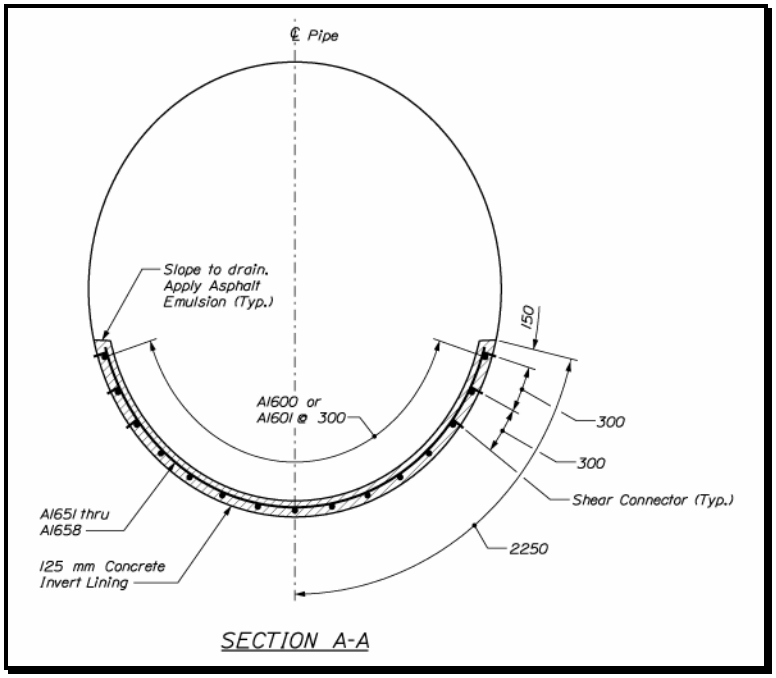

Figure 6-4 Invert Lining Section

Intro: the section shows the thickness and limits of the invert lining, as well as the reinforcing steel.

Sheet up: Belongs on invert lining sheet

Scale: ½" = 1'-0"

Draw:

1) CL Pipe
2) Existing Structure
3) Invert Lining
4) Reinforcing Steel
5) Shear Connector

Dimension:

1) Limits of Concrete. Usually given as a length along the curve of the existing structure, measured from the invert up to the top of the invert lining.
2) Reinforcing Steel, Shear Connectors

Label:

1) Detail Name
2) CL Pipe
3) Invert Lining

4) Shear Connectors
5) Reinforcing Steel
6) Slope to top of lining to drain

CHAPTER 7 MISCELLANEOUS

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7.2 Title Sheet & Estimated Quantities

These sheets present design and construction specifications, materials and material strengths, technical data, and general construction methods. They serve to link the plans, specifications and estimate.

7.2.1 Typical Sheet Names and Contents

7.2.1.1 Title Sheet

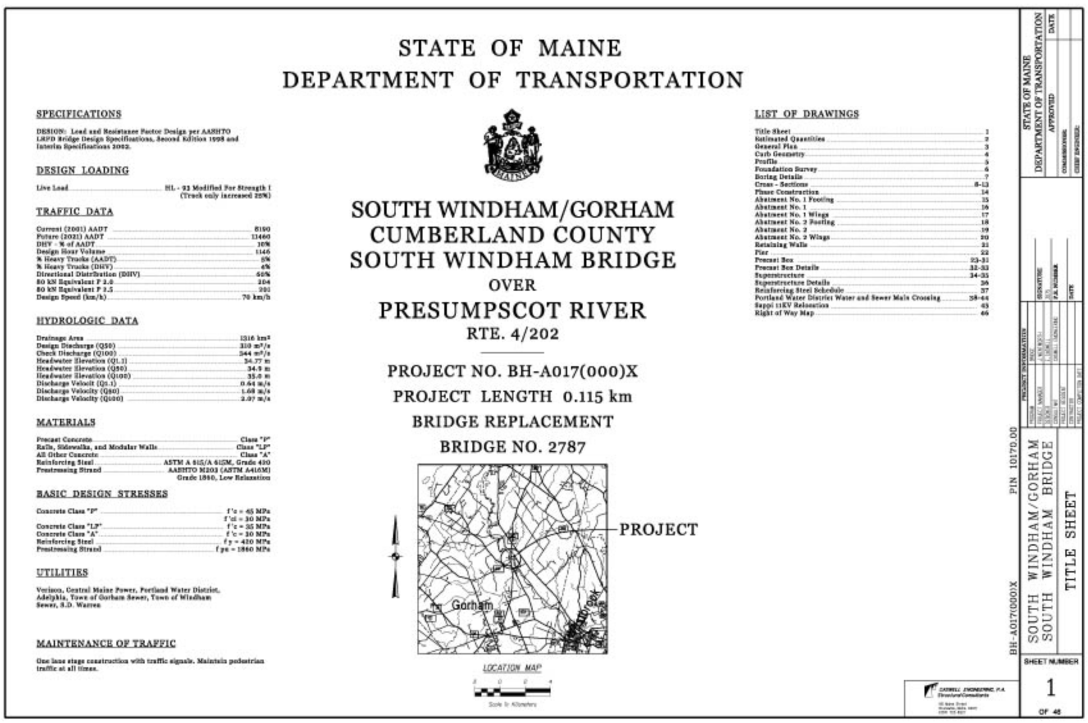

Figure 7-1 Title Sheet

Will Contain:

1) MeDOT Logo
2) Title Information
3) Bridge Name
4) Crossing (river, stream, RR, etc.)
5) Town, City
6) County
7) Location Map
8) North Arrow
9) Bar Scale

10) Project Location
11) Project Length (Does not include transitions)
12) Project Number
13) Project Description (Bridge Replacement, Culvert Invert Lining, Sliplining, Deck Replacement, Wearing Surface Replacement, Bridge Rehabilitation, Bridge Painting, etc.)
14) Index of sheets
15) Bridge sheets & ROW map
16) Bridge standard details
17) Highway standard details
18) Signature block w/PE stamp
19) Hydrologic data
20) Traffic data
21) Specifications

May Contain:

1) Consultant Logo

7.2.1.2 Estimated Quantities

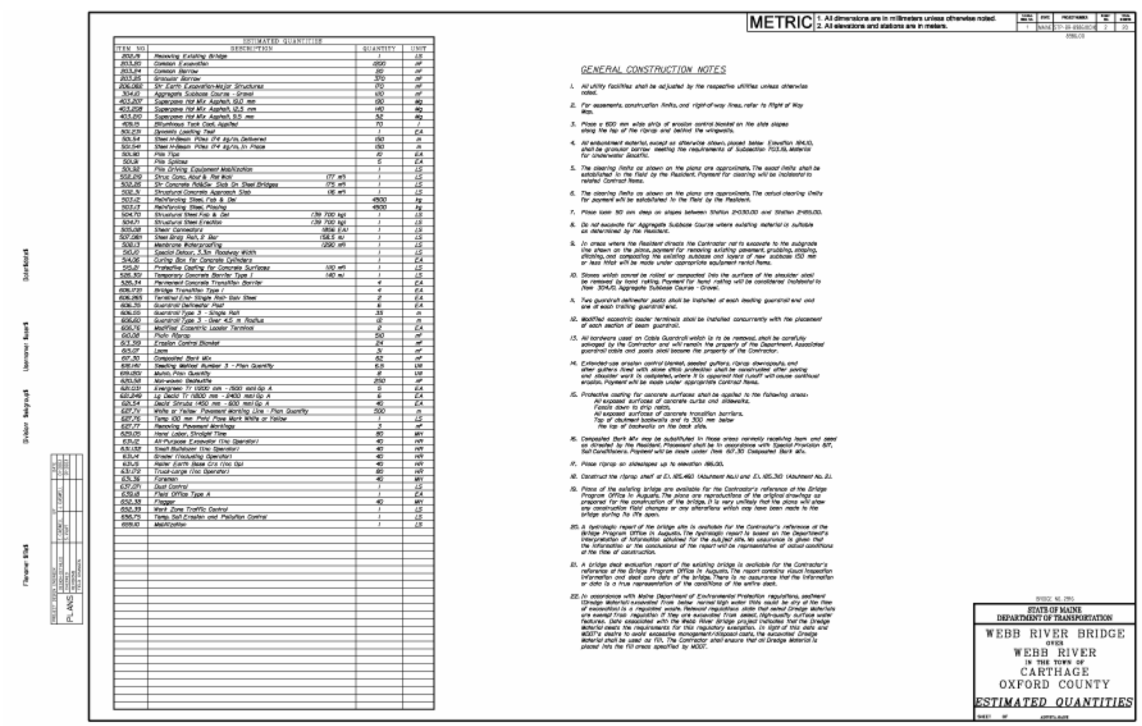

Figure 7-2 Estimated Quantities Sheet

Will Contain:

1) Table of Estimated Quantities
2) Construction Notes

7.2.2 Standard Notes

7.2.2.1 SPECIFICATIONS

DESIGN: Load and Resistance Factor Design per AASHTO LRFD Bridge Design Specifications Fourth Edition 2007.

DESIGN: Allowable Stress Design per AASHTO Standard Specifications for Highway Bridges 1996, and all supplementals thereto.

7.2.2.2 TRAFFIC DATA

Current (200X) AADT = XXXX

Future (20XX) AADT = XXXX

DHV - % of AADT = XX %

Design Hour Volume = XXX

Heavy Trucks (% of AADT) = XX %

Heavy Trucks (% of DHV) = XX %

Directional Distribution (% of DHV) = XX %

18 Kip Equivalent P 2.0 = XX

18 Kip Equivalent P 2.5 = XX

Design Speed = XX mph

7.2.2.3 DESIGN LOADING

LIVE LOAD: HL-93 Modified for Strength I (Truck only increased 25%)

7.2.2.4 MATERIALS

CONCRETE:

Structural Wearing Surface	Class LP
Barriers, Curbs, Sidewalks, End Posts	Class LP
Seals	Class S
Precast	Class P
Fill	Fill
All Other	Class A

REINFORCING STEEL: ASTM A615/A615M Grade 60

PRESTRESSING STRANDS:	AASHTO 203 (ASTM A416), Grade 270, Low Relaxation
STRUCTURAL STEEL:	
All Material (unless otherwise noted)	ASTM A709, Grade 50W (unpainted)
High Strength Bolts	ASTM A325M, Type 3

7.2.2.5 BASIC DESIGN STRESSES

CONCRETE:	f'c = 4,350 psi
PRECAST CONCRETE:	f'c = XX psi f'ci = XX psi
REINFORCING STEEL:	fy = 60,000 psi
PRESTRESSING STRANDS:	fy = 270,000 psi
STRUCTURAL STEEL:	
ASTM A709, Grade 345W	Fy = 50,000 psi
ASTM A709, Grade 250	Fy = 36,000 psi
ASTM A325	Fu = 120,000 psi

7.2.2.6 HYDROLOGIC DATA

Drainage Area = _______sq mi

Design Discharge (Q50) = _______cfs

Check Discharge (Q100) = _______cfs

Headwater Elev. (Q50) = _______ft

Headwater Elev. (Q100) = _______ft

Discharge Velocity (Q50) = _______fps

Discharge Velocity (Q100) = _______fps

Headwater Elev. (Q1.1) = _______ft

Discharge Velocity (Q1.1) = _______fps

Mean Lower Low Water (MLLW) = -X.XX ft

Mean Low Water (MLW) = -X.XX ft

Mean Tide Level (MTL) = X.XX ft

Mean High Water (MHW) = X.XX ft

Mean Higher High Water (MHHW) = X.XX ft

20__ Predicted High Tide = X.XX ft

7.2.2.7 Coast Guard Permit

(The following note is used only when a Coast Guard Permit is required, and should be the only note to be put on the plans in reference to permits.)

COAST GUARD PERMIT REQUIRED

7.2.2.8 General Construction Notes

1) All utility facilities shall be adjusted by the respective utilities unless otherwise noted.
2) For easements, construction limits, and right-of-way lines, refer to Right of Way Map.
3) During construction, the road will be closed to traffic for a time period specified in the Special Provisions.
4) Place a 24 in. wide strip of Temporary Erosion Control Blanket on the side slopes along the top of the riprap and behind the wingwalls and headwalls.
5) All embankment material, except as otherwise shown, placed below Elevation XX, shall be Granular Borrow meeting the requirements of Subsection 703.19, Material for Underwater Backfill.

(The following note shall be shown on the plans when the quantity of clearing is one half acre or less and no separate payment is to be made.)

6) The clearing limits as shown on the plans are approximate. The exact limits will be established in the field by the Resident. Payment for clearing will be considered incidental to related Contract items.

(The following note is used when the clearing quantity is more than on half acre and a pay item for clearing is to be included.)

7) The clearing limits as shown on the plans are approximate. The actual clearing limits for payment will be established in the field by the Resident.
8) Place loam 2 inches deep on all new or reconstructed sideslopes or as directed by the Resident.
9) Do not excavate for Aggregate Subbase Course where existing material is suitable as determined by the Resident.
10) In areas where the Resident directs the Contractor not to excavate to the subgrade line shown on the plans, payment for removing existing pavement, grubbing, shaping, ditching, and compacting the existing subbase and layers of new subbase 6 inches or less thick will be made under appropriate equipment rental items.

(The following note is used when unscreened gravel such as aggregate subbase gravel is designated as surface material in the shoulders.)

11) Stones which cannot be rolled or compacted into the surface of the shoulder shall be removed by hand raking. Payment for hand raking will be considered incidental to Item 304.10 Aggregate Subbase Course -Gravel.

(The following note shall be used on newly constructed projects when the future AADT is 500 or more)

12) A NCHRP350 compliant guardrail end treatment shall be installed concurrently with the placement of each section of beam guardrail.

(The following note shall be used on newly constructed projects when the future AADT is less than 500)

13) A Low Volume Guardrail End shall be installed concurrently with the placement of each section of beam guardrail.

14) Extended-use Erosion Control Blanket, seeded gutters, riprap downspouts, and other gutters lined with Stone Ditch Protection shall be constructed after paving and shoulder work is completed, where it is apparent that runoff will cause continual erosion. Payment will be made under the appropriate Contract items.

(The following note is used on the plans for Reduced Berm Offsets)

15) Guardrail posts as shown in the *Standard Details* shall be modified from the indicated length of 6 feet to a length of 7 feet with an embedment of 4.5 feet. Payment will be considered incidental to the guardrail pay items.

16) Protective coating for concrete surfaces shall be applied to the following areas:

    a) All exposed surfaces of concrete curbs and sidewalks,

    b) Fascia down to drip notch,

    c) All exposed surfaces of concrete transition barriers,

    d) Concrete wearing surfaces,

    e) Concrete barrier railing,

    f) Top of abutment backwalls and to 12 inches below the top of backwalls on the back side.

17) Erosion Control Mix may be substituted in those areas normally receiving loam and seed as directed by the Resident. Placement shall be in accordance with Standard Specifications Section 619, Mulch. Payment will be made under Item 619.1401 Erosion Control Mix.

[The following two notes are used in conjunction with Standard Detail 610(2-4).]

18) Place riprap on sideslopes up to elevation XX.

19) Construct the riprap shelf at each abutment at elevation XX.

(The following five notes are used as needed.)

20) Bidders and Contractors may obtain a copy of the existing bridge plans by faxing a Request for Information to the Bid Contact Person. The plans are reproductions of the original drawings as prepared for the construction of the bridge. It is very unlikely that the plans will show any construction field changes or any alterations, which may have been made to the bridge during its life span.

21) Bidders and Contractors may obtain a copy of the hydrologic report of the bridge site by faxing a Request for Information to the Bid Contact Person. The hydrologic report is based on the Maine DOT's interpretation of the information obtained for the subject site. No assurance is given that the information or the conclusions of the report will be representative of actual conditions at the time of construction.

22) Bidders and Contractors may obtain a copy of the bridge deck evaluation report of the existing bridge by faxing a Request for Information to the Bid Contact Person. The report contains visual inspection information and deck core data of the bridge. There is no assurance that the information or data is a true representation of the conditions of the entire deck.

23) Bidders and Contractors may obtain a copy of the project geotechnical report(s), Name of Report(s), MaineDOT Soils Report Number(s), date(s), by faxing a Request for Information to the Bid Contact Person.

24) Geotechnical information furnished or referred to in this plan set is for the use of the Bidders and Contractor. No assurance is given that the information or interpretations will be representative of actual subsurface conditions at the construction site. Maine DOT will not be responsible for the Bidder's and Contractor's interpretations of, or conclusions drawn from, the geotechnical information. The boring logs contained in the plan set present factual and interpretive subsurface information collected at discrete locations. Data provided may not be representative of the subsurface conditions between boring locations.

(The following note is to be used when removing an existing aluminum bridge rail.)

25) All aluminum bridge rail, rail posts, and associated hardware which are to be removed shall be carefully salvaged by the Contractor and will remain the property of the Department. Payment shall be incidental to related Contract items.

(Cofferdam pay items will be used when the use of such an item is clearly required. In situations where the need for a cofferdam is in question, then no cofferdam pay item would be included, and the following note would be put on the plans. Consequently, when a cofferdam pay item is included, this item must clearly identify the location at which it is intended to be used, particularly when both cofferdam pay items and the following note are included in the same contract. Furthermore, if both are used, the following note should be modified to clearly state which cofferdam is incidental.)

26) All costs for cofferdams, including pumping, maintenance, related temporary soil erosion and water pollution controls and removal will not be paid for directly, but will be considered incidental to related Contract Items.

(The following note is primarily intended to inform the Bidders that the existing structure to be removed is coated with lead-based paint. Therefore any contract where the existing structure is to be removed, and the structure contains lead paint, should have this note on the plans. A similar note should be created and included in any contract where the existing structure contains lead paint and is to be rehabilitated.)

27) The existing bridge shall be removed by, and become the property of, the Contractor. The steel portions of the existing bridge are coated with a lead-based paint system. The Contractor is responsible for the containment, proper management and disposal of all lead-contaminated hazardous waste generated by the process of demolishing the bridge. The Contractor is responsible for implementing appropriate OSHA mandated personal protection standards related to this process. Once the existing bridge is removed, the Contractor is solely responsible for the care, custody and control of the components of the existing bridge and any hazardous waste generated as a result of storage, recycling, or disposal of the bridge components, including the lead-coated steel. The Contractor shall recycle or reuse the steel in accordance with Maine Department of Environmental

Protection's "Maine Hazardous Waste Management Regulations," Chapter 850. A copy of this regulation is available at the MaineDOT's offices on Child Street in Augusta. Payment for all labor, materials, equipment, and other costs required to remove and dispose of the existing bridge will be considered incidental to the bridge removal pay item.

(The following note may be included on the plans where the existing bridge, regardless of type or size, is to be removed and a demolition plan is necessary.)

28) The Contractor shall submit a Bridge Demolition Plan to the Resident at least 10 business days prior to the start of demolition work. This plan shall outline the methods and equipment to be used to remove and dispose of all materials included in the existing bridge. No work related to the removal of the bridge shall be undertaken by the Contractor until the MaineDOT has reviewed the Bridge Demolition Plan for appropriateness and completeness. Payment for all work necessary for developing, submitting and finalizing the Demolition Plan will be considered incidental to the bridge removal pay item.

(The following note shall be included on the plans whenever lump sum items are included in the contract.)

29) Quantities included for pay items measured and paid by Lump Sum are estimated quantities and are provided by the MaineDOT for informational purposes only. Lump Sum items will be paid for at the Contract Bid amount, with no addition or reduction in payment to the Contractor if the actual final quantities are different from the MaineDOT provided estimated quantities unless:

- If a Lump Sum pay item is eliminated, the requirements of Standard Specification Section 109.2, Elimination of Items, will take precedence.
- If other Contract Documents specifically allow a change in payment for a Lump Sum pay item, those requirements will be followed.
- If a design change results in changes to estimated quantities for Lump Sum pay items, price adjustments will be made in accordance with Standard Specification Section 109.7, Equitable Adjustments to Compensation.

7.2.3 Checklists

7.2.3.1 Location Map

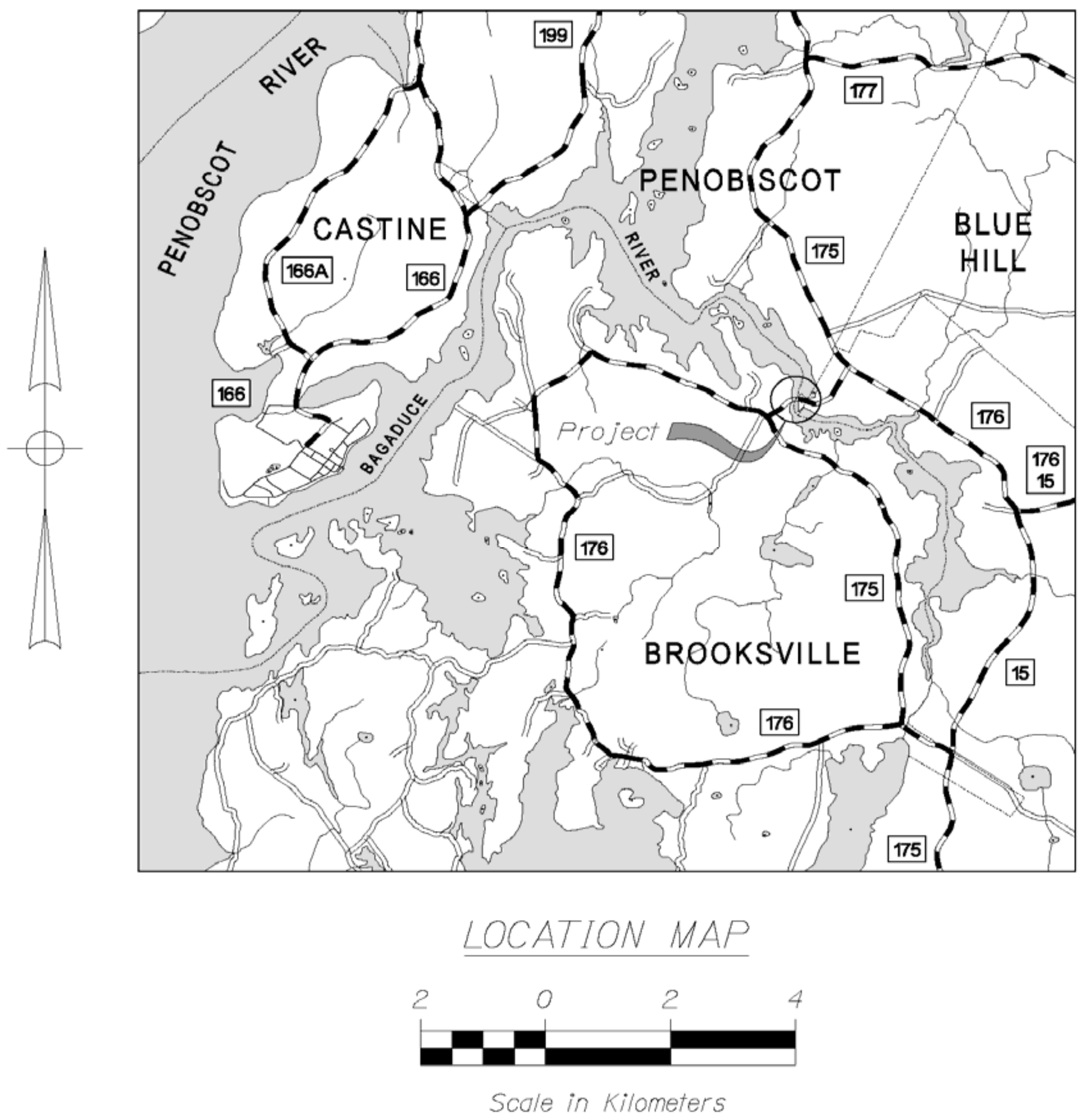

Figure 7-3 Location Map

A location map needs to be provided, typically on the first sheet along with the plan view. Show the following:

1) Project location: cut the map such that it contains both the project and a local landmark such as an adjacent town.
2) Scale: show a bar scale.
3) North arrow: typically aligned with "up" on the page.

7.2.3.2 Utilities List

The list on the preliminary plan may include all of the utilities in the town because it may be the only information that you have at this time. The final list should only include the utilities within the project limits.

(Reference the *Bridge Design Guide* - Appendix D for the most up to date format)

7.2.3.3 Maintenance Of Traffic

Describe the maintenance of traffic in very general terms. If it is a bridge closure, tell how long the duration of the closure will be. If it is a detour over nearby roads tell which roads if you can. If it is an on site detour tell how many lanes of traffic will be maintained and by what method.

7.2.3.4 Scope Of Work

This is preferably written in the order that the work will be done.

7.2.3.5 Approximate Cost (Including Engineering)

7.2.3.6 Traffic Data

7.2.3.7 Design Loading

Sometimes the following verbiage is added on pipe type projects:

(Truck only increased 25%)

7.2.3.8 Specifications

♬ The specifications note as it appears in the Microstation settings manager is not worded the same as it is in the *Bridge Design Guide*. The correct year should be stated in the *BDG* and updated when *AASHTO* is updated so that everyone will be made aware of the change.

7.2.3.9 Materials

7.2.3.10 Basic Design Stresses

7.2.3.11 Hydrologic Data

7.2.3.12 Coast Guard Permit Required

7.2.3.13 Construction Notes

7.3 Geotechnical

7.3.1 Introduction

The MeDOT geotechnical plans are typically developed by the Material Testing and Exploration unit in Bangor. They provide information on the subsurface soil conditions.

7.3.2 Prerequisites

You will need:

1) Complete topo
2) Final alignment
3) Plan and Profile views
4) Boring Locations
5) Boring Data

7.3.3 Standard Notes

Reference Chapter 7 General Construction Notes for geotechnical related notes.

7.3.4 Typical Sheet Names and Contents

7.3.4.1 Boring Location Plan

7.3.4.2 Interpretive Subsurface Profile

7.3.4.3 Boring Logs

When there is room, the Boring Location Plan and Interpretive Subsurface Profile are combined on the same sheet.

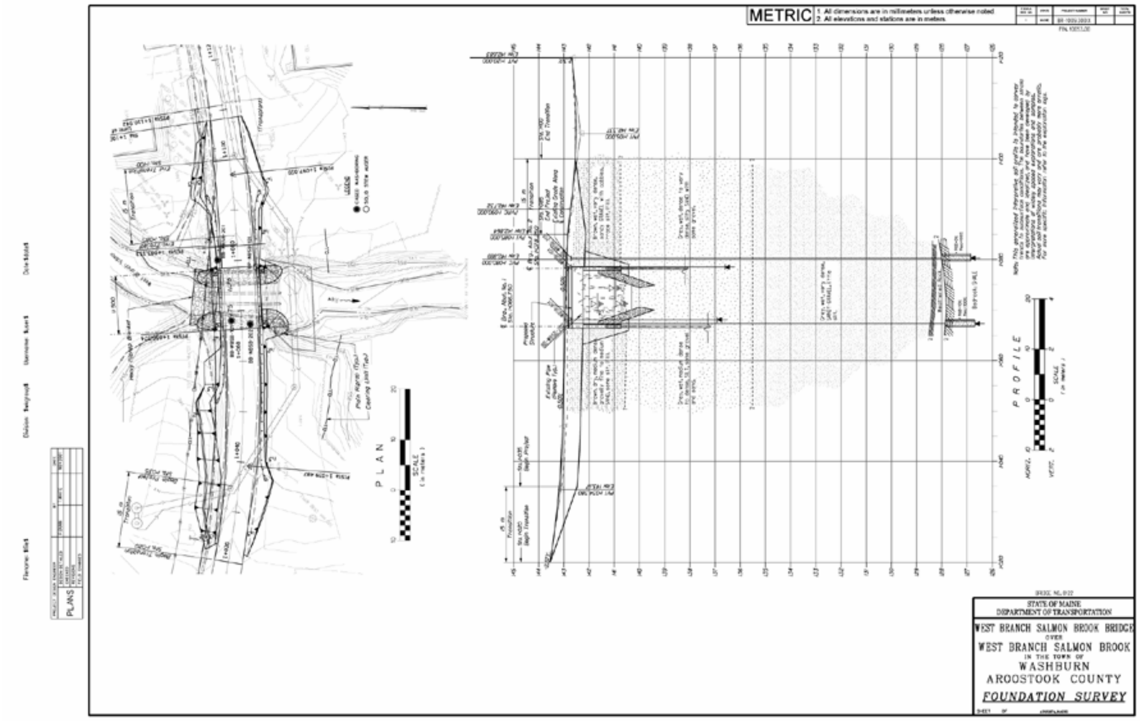

Figure 7-4 Boring Location Plan and Interpretive Subsurface Profile

Will Contain:

1) Survey Plan with Boring Locations
2) Foundation Profile

7.3.5 Checklists

7.3.5.1 Boring Location Plan

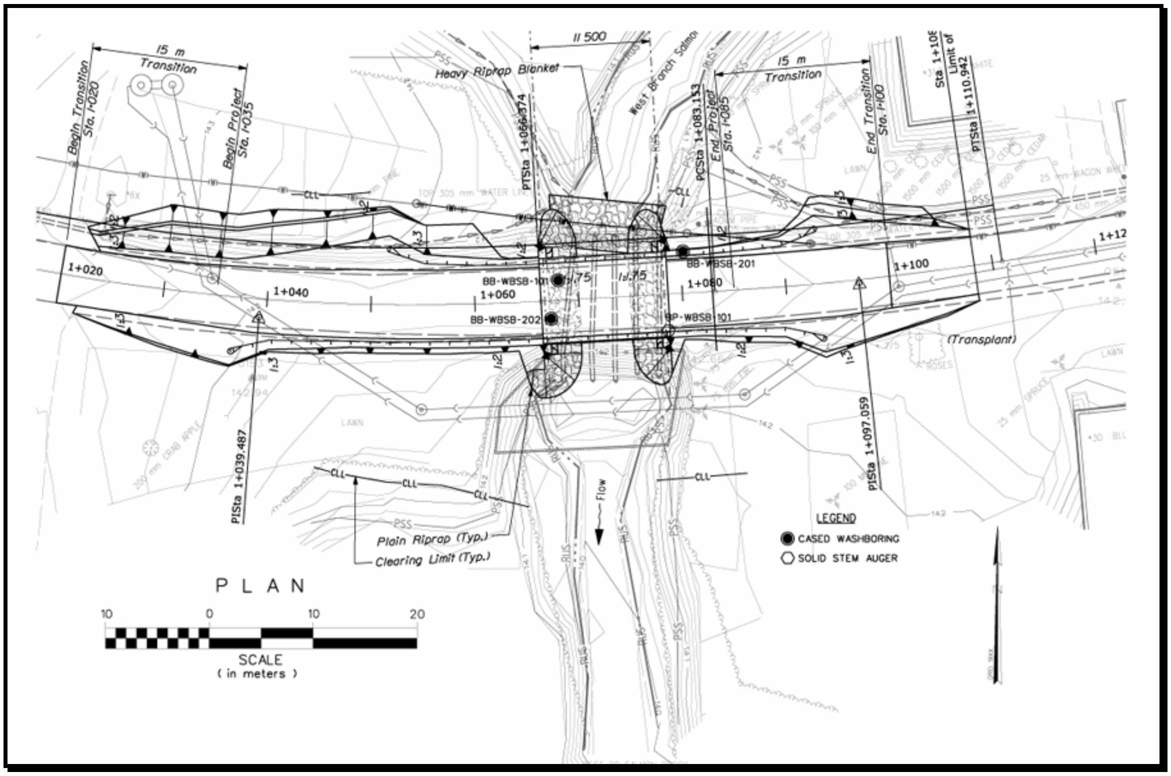

Figure 7-5 Boring Location Plan

Intro: Boring Location Plan shows boring locations.

Sheet up: belongs on Boring Location Plan Sheet

Scale: same as bridge plan, usually 1”=25’

Draw:

1) Bridge Plan
2) Temporary Detour
3) Contours
4) Survey
5) Boring Locations

Label:

1) Detail Name “PLAN”
2) Scale with Bar Scale
3) Boring Symbol Legend

7.3.5.2 Interpretive Subsurface Profile

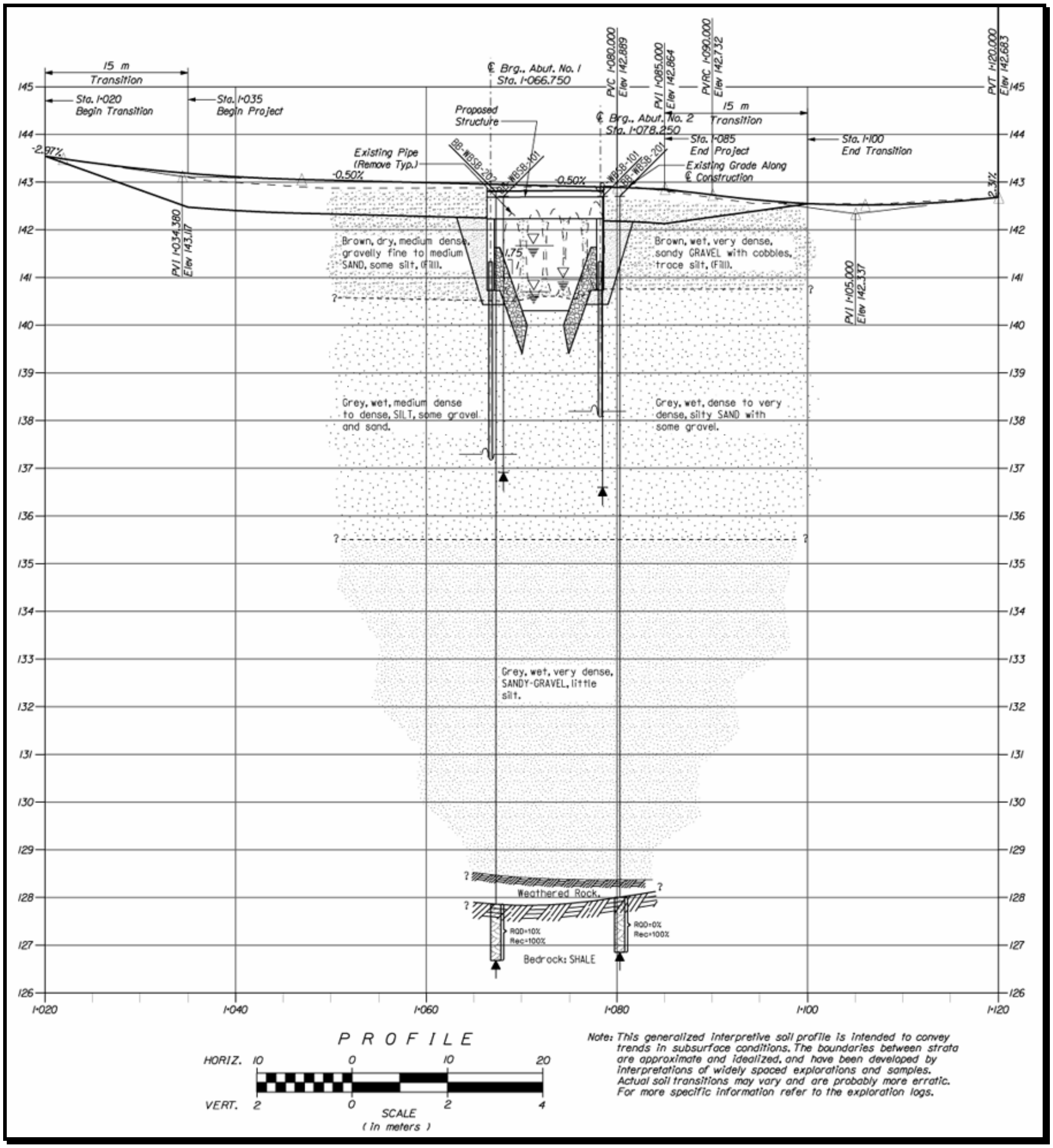

Figure 7-6 Interpretive Subsurface Profile

Intro: Interpretive Subsurface profile shows soils, ledge, and boring locations.

Sheet up: belongs on Interpretive Subsurface Profile sheet or combined with the Boring Location Plan

Scale: same as profile, 1"=25 horizontal, 1"=5' vertical

Draw:

1) Profile (start with complete bridge profile and extend vertically)

2) Soils
3) Ledge
4) Boring locations

Label:

1) Detail Name ("PROFILE")
2) Scale (w/ Bar Scale)
3) Horizontal and Vertical Grid Lines
4) Soils
5) Borings

7.3.5.3 Boring Logs

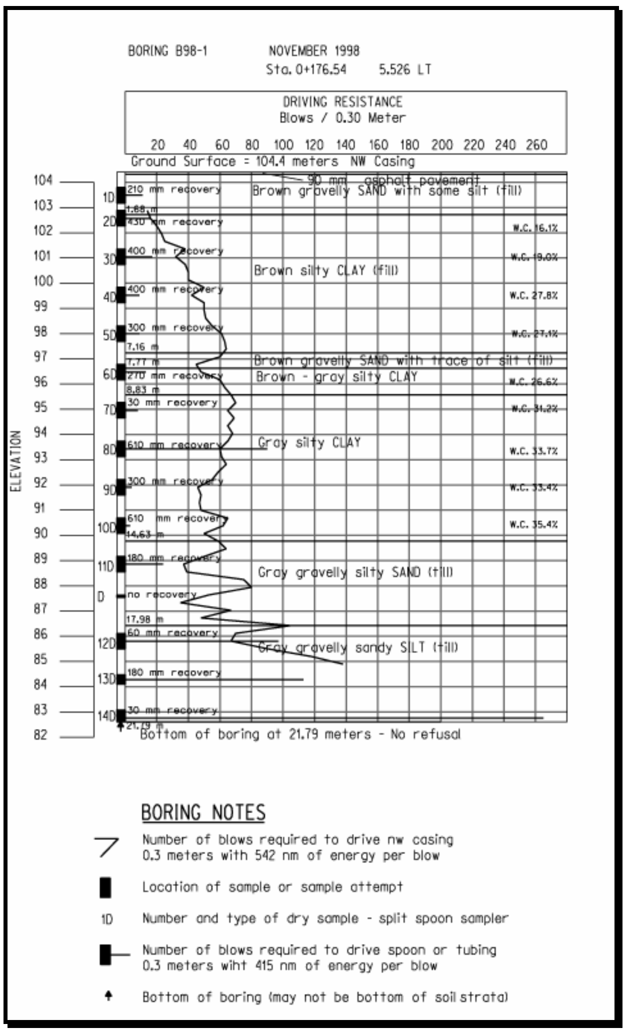

Figure 7-7 Boring Logs

7.4 Staged Construction

7.4.1 Introduction

The staged construction sheet consists of a series of transverse sections showing the maintenance of traffic during removal of the existing bridge and construction of the new bridge.

7.4.2 Prerequisites

The following information should be gathered before you begin detailing:

1) Existing bridge transverse section
2) New bridge transverse section
3) Maintenance of traffic scheme for vehicular traffic and if required, pedestrian traffic
4) Location of existing and proposed utilities on bridge.
5) Staged Construction Notes

7.4.3 Detailing

The number of construction stages varies between projects and depends on individual project requirements. Shading can be use to indicate portions of existing bridge to be removed.

♬ The Staged Construction Notes play an important role in communicating the Staged Construction scheme. Make sure the details accurately reflect the scheme presented in the notes.

7.4.4 Typical Sheet Names and Contents

7.4.4.1 Staged Construction

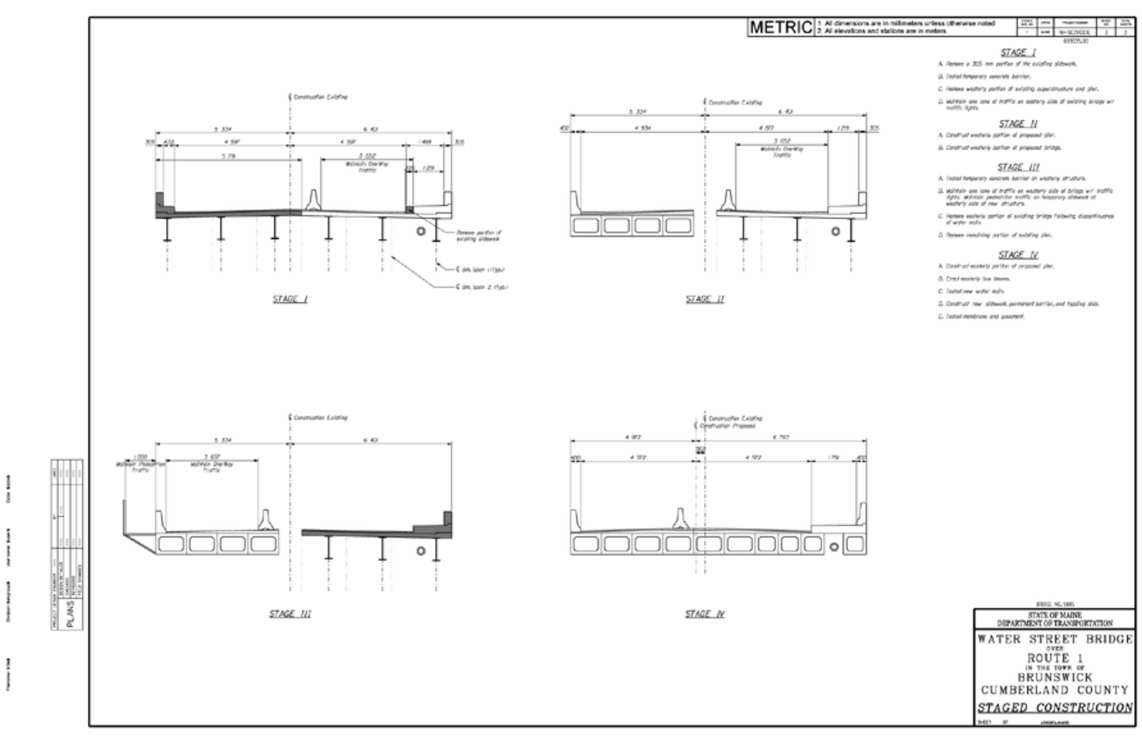

Figure 7-8 Staged Construction Sheet (Typical Bridge)

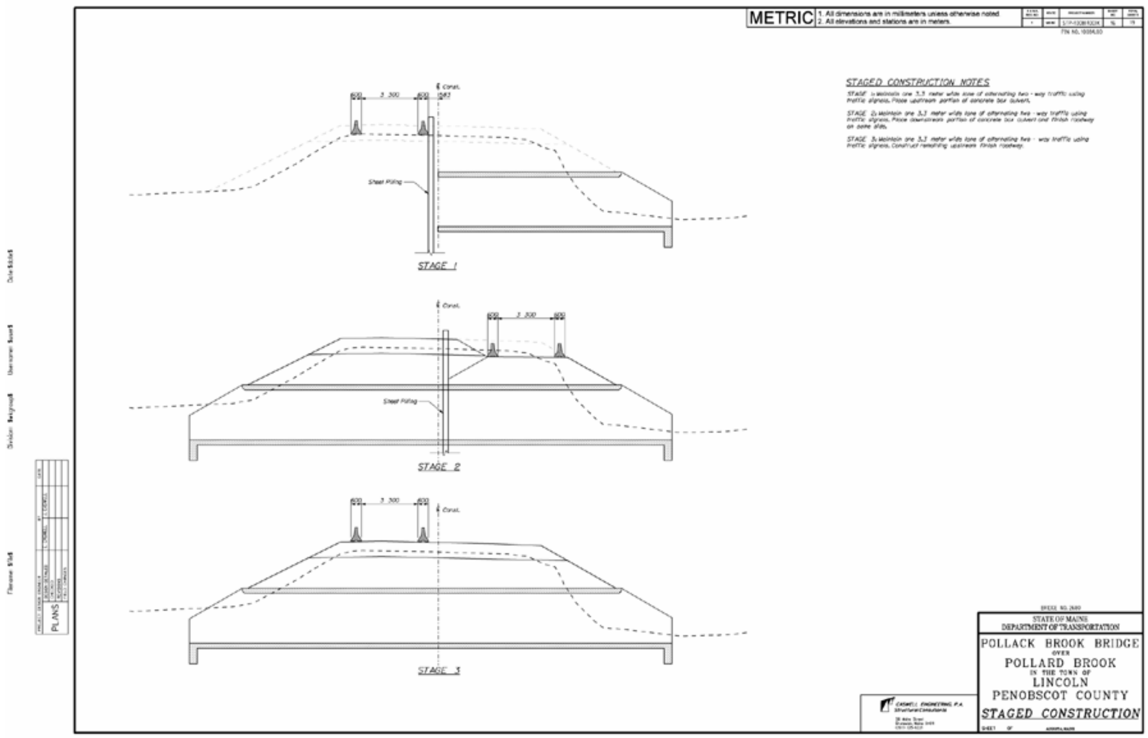

Figure 7-9 Staged Construction Sheet (Buried Structure)

Will Contain:

1) Stage I, II, etc. (Transverse Sections)
2) Staged Construction Notes

7.4.5 Checklists

7.4.5.1 First Stage

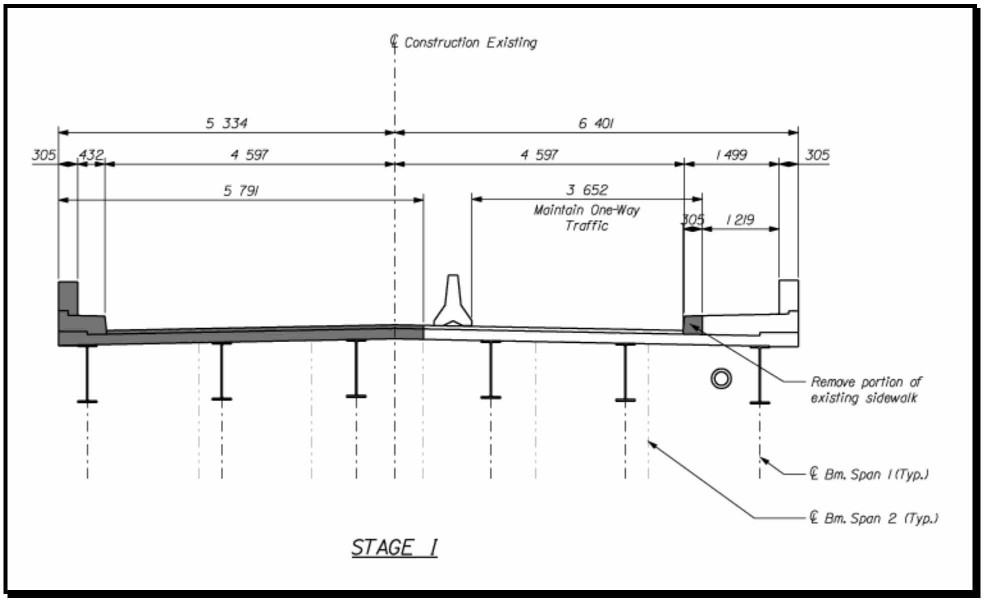

Figure 7-10 Staged Construction (Stage I)

Intro: Transverse section showing first stage of construction: shifting traffic to one side of bridge and removing the other.

Sheet up: Belongs in the upper left of the Staged Construction sheet.

Scale: ¼".

Draw:

1) Centerline of Existing Construction/Working Line
2) Transverse section of existing bridge. Shade portion to be removed.
3) Temporary concrete barriers
4) Existing utilities supported from bridge

Dimension:

1) Temporary travel way and if required, pedestrian way.
2) Construction joint

Label:

1) Temporary concrete barrier
2) Maintain one-way/two-way traffic
3) Maintain pedestrian traffic
4) Construction joint

7.4.5.2 Transitional Stages

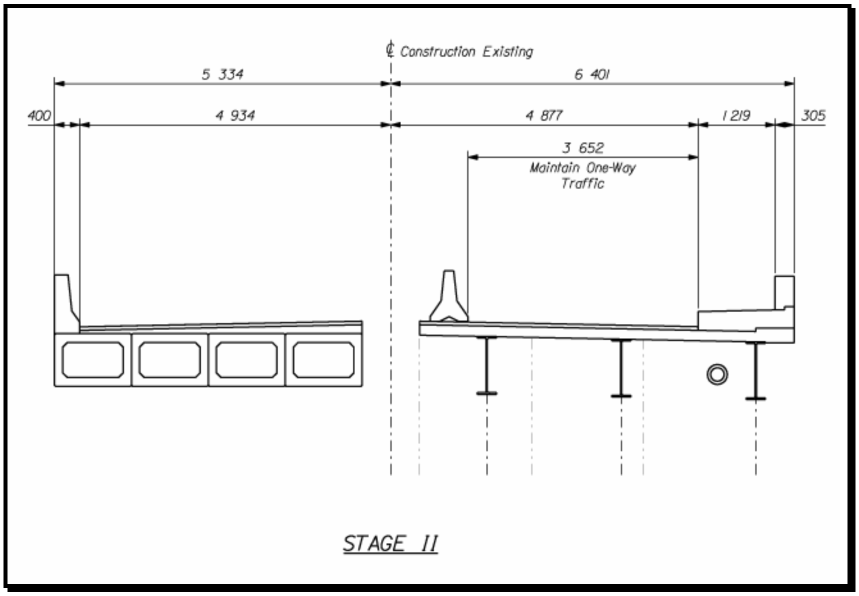

Figure 7-11 Staged Construction (Early Intermediate Stage)

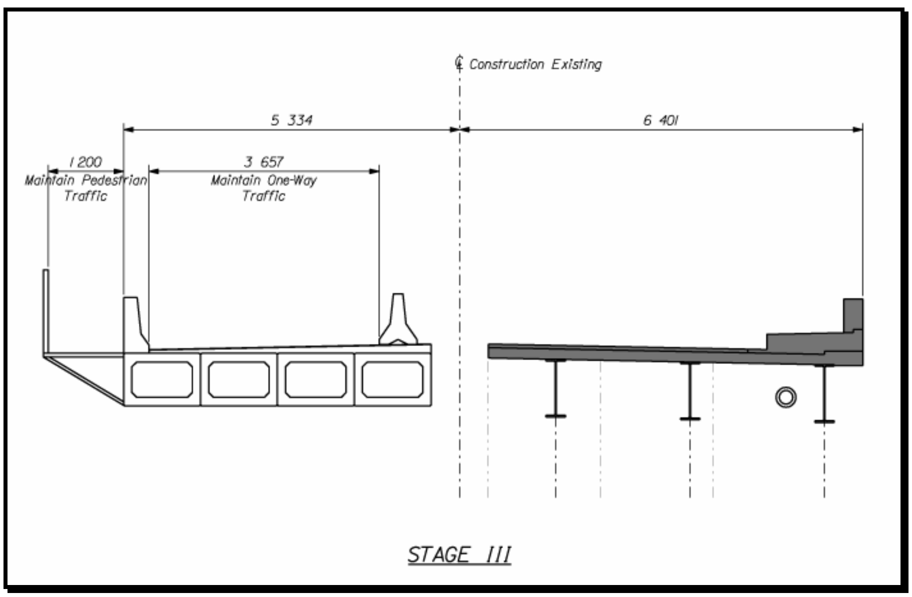

Figure 7-12 Staged Construction (Late Intermediate Stage)

Intro: Transverse sections showing intermediate stages of construction: constructing portions of new bridge, shifting of traffic to new bridge and removing remaining portion of old bridge. The number of stages depends on individual project requirements.

Sheet up: Belongs on Staged Construction Sheet. Check sheet up before proceeding. If all stages won't fit in a vertical alignment, locate subsequent stages so that they read left to right.

Scale: ¼"

Draw:

1) Centerline of Existing Construction/Working Line
2) Centerline of Proposed Construction/Working Line
3) Transverse sections of the existing and new bridge as required showing the progression of construction. Shade portions of existing bridge to be removed.
4) Temporary concrete barriers
5) Temporary sidewalks, if required
6) Existing utilities supported from bridge

Dimension:

1) Temporary travel way and if required, pedestrian way.
2) Offset between Existing and Proposed Construction/Working Line

Label:

1) Temporary concrete barrier
2) Maintain one-way traffic
3) Maintain pedestrian traffic
4) Construction joint

7.4.5.3 Final Stage

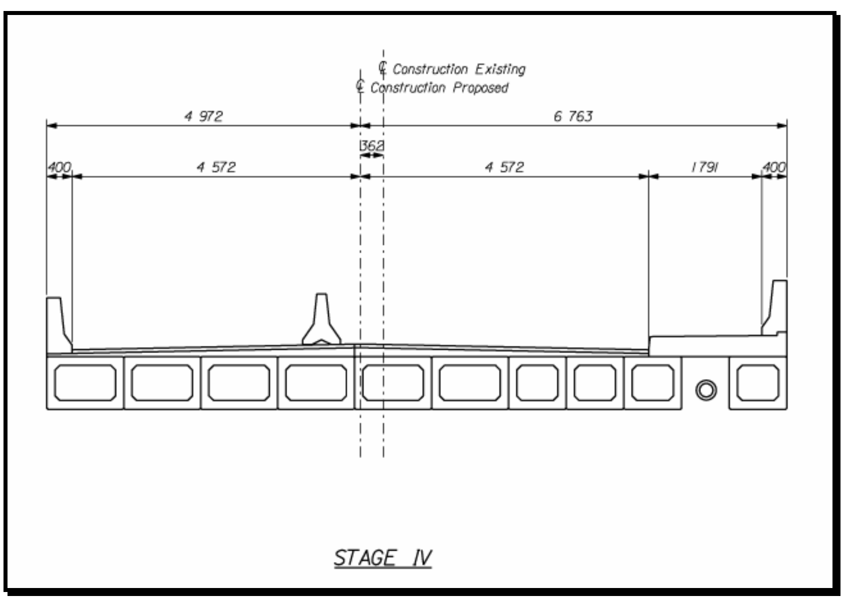

Figure 7-13 Staged Construction (Final Stage)

Intro: Transverse section showing completed bridge. During the final stage additional shifting traffic may be required to complete sidewalks, rails and paving.

Sheet up: Belongs on Staged Construction Sheet. Check sheet up before proceeding. If all stages won't fit in a vertical alignment, locate subsequent stages so that they read left to right.

Scale: ¼".

Draw:

1) Centerline of Existing Construction/Working Line
2) Centerline of Proposed Construction/Working Line
3) Transverse section of completed bridge
4) Temporary concrete barriers
5) Utilities supported from bridge

Dimension:

1) Temporary travel way

Label:

1) Maintain one-way/two way traffic
2) Traffic Control
3) Introduction
4) Prerequisites

7.5 Traffic Control

7.5.1 Detailing

Sometimes the traffic control plans are drawn by the detailer as part of the contract plans. Sometimes they are in the form of a specification, and included in the contract book. Then again, sometimes they are required to be developed by the Contractor. Check with the designer to see how this will be handled.

7.5.2 Typical Sheet Names and Contents

7.5.2.1 Detour Plan or Traffic Control Plan

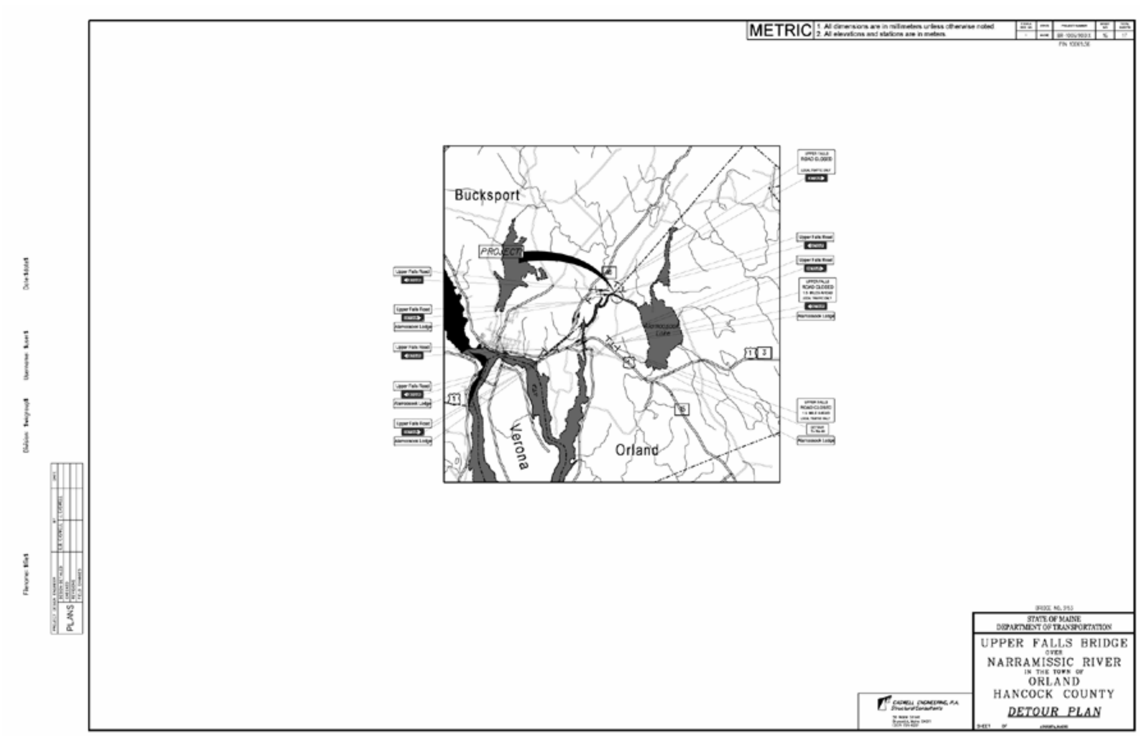

Figure 7-14 Detour Plan

Will Contain:

1) Detour Plan

7.5.3 Checklists

7.5.3.1 Detour Plan

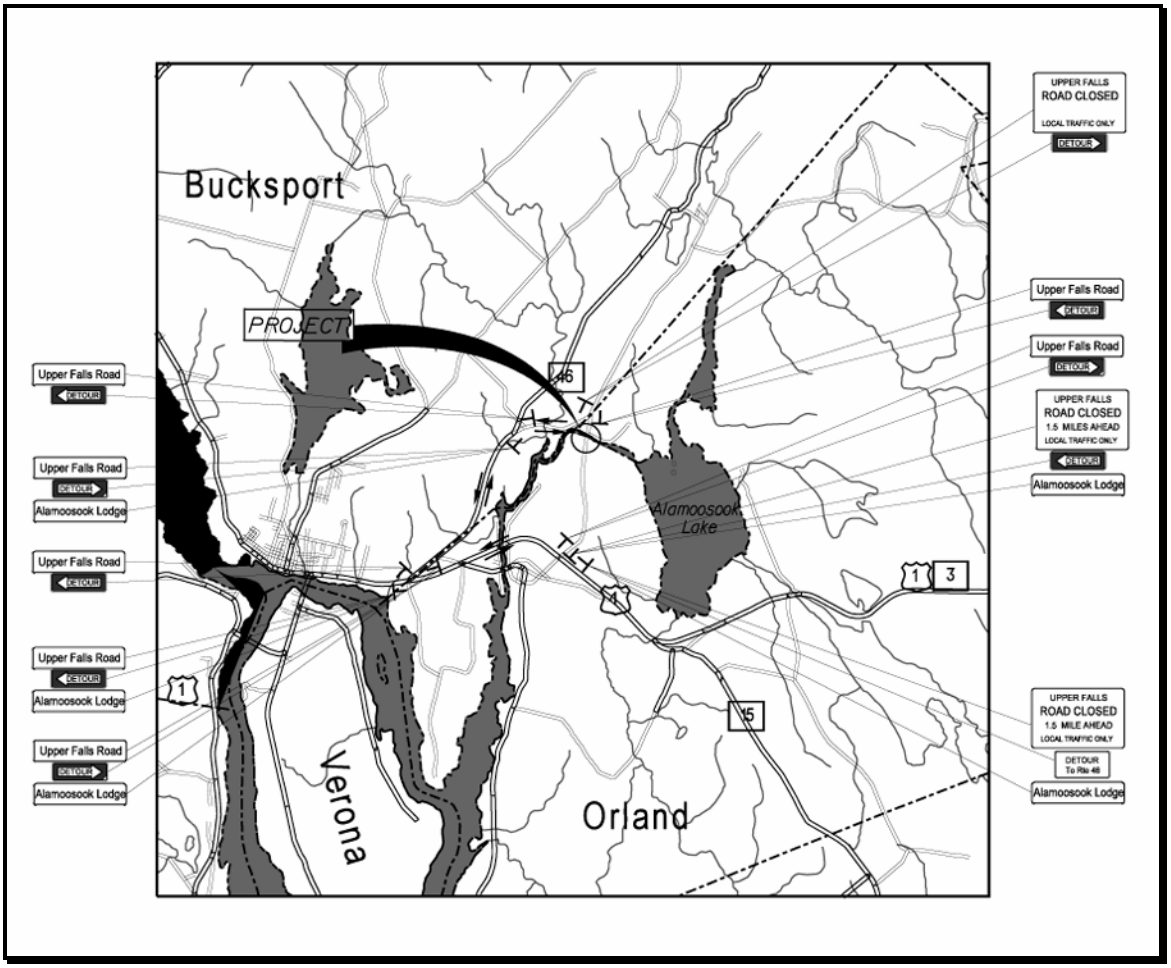

Figure 7-15 Detour Plan

Intro: shows signage requirements on a map of the vicinity of the project

Sheet up: belongs on Detour Plan Sheet

Scale: start from location map of same scale as title sheet.

Draw:

1) Location Map
2) Sign types and locations

Label:

1) Project Location
2) Towns, Route Numbers, Bodies of Water
3) Location and orientation of each sign type

7.6 Fish Passage Structures

7.6.1 Introduction

One of the important considerations of designing a bridge is maintaining the ability of fish to be able to pass through the bridge. Often time's metal pipe inverts are too high and have very little flow. This can inhibit fish passage. This condition can be made worse when the invert of the pipe needs to be rehabilitated and concrete is added thus raising the invert. One of the ways to mitigate the situation is by utilizing a pool and weir system. The following is one example of a weir system constructed inside a pipe.

7.6.2 Prerequisites

You will need:

1) Existing Survey with invert elevations
2) Proposed and checked bridge structure geometry design
3) Reinforcement Design

7.6.3 Detailing

Details for fish weirs are explicit rather than performance-based. The Contractor is the main client to consider when detailing.

The geometry of these structures and can be a challenge for the designer to nail down, and a challenge to detail. The location and elevations of the weirs and the notches can be subjective, but are key to the systems success.

7.6.4 References

Maine Department of Transportation Fish Passage Policy & Design Guide

7.6.5 Typical Sheet Names and Contents

7.6.5.1 Structure Sheet with Fish Weir

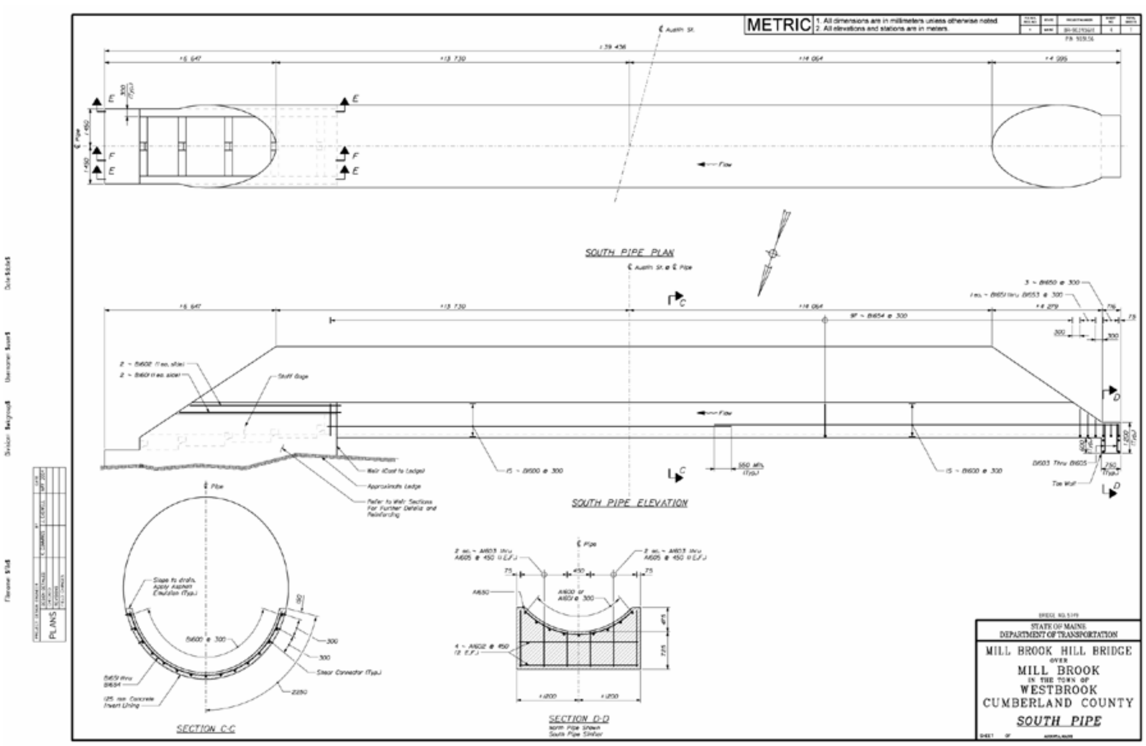

Figure 7-16 Structure Sheet with Fish Weir

The fish weir may be shown on a structure sheet.

Will Contain:

1) Plan
2) Elevation
3) Section

May Contain:

1) Other Details
2) Notes

7.6.5.2 Weir Details

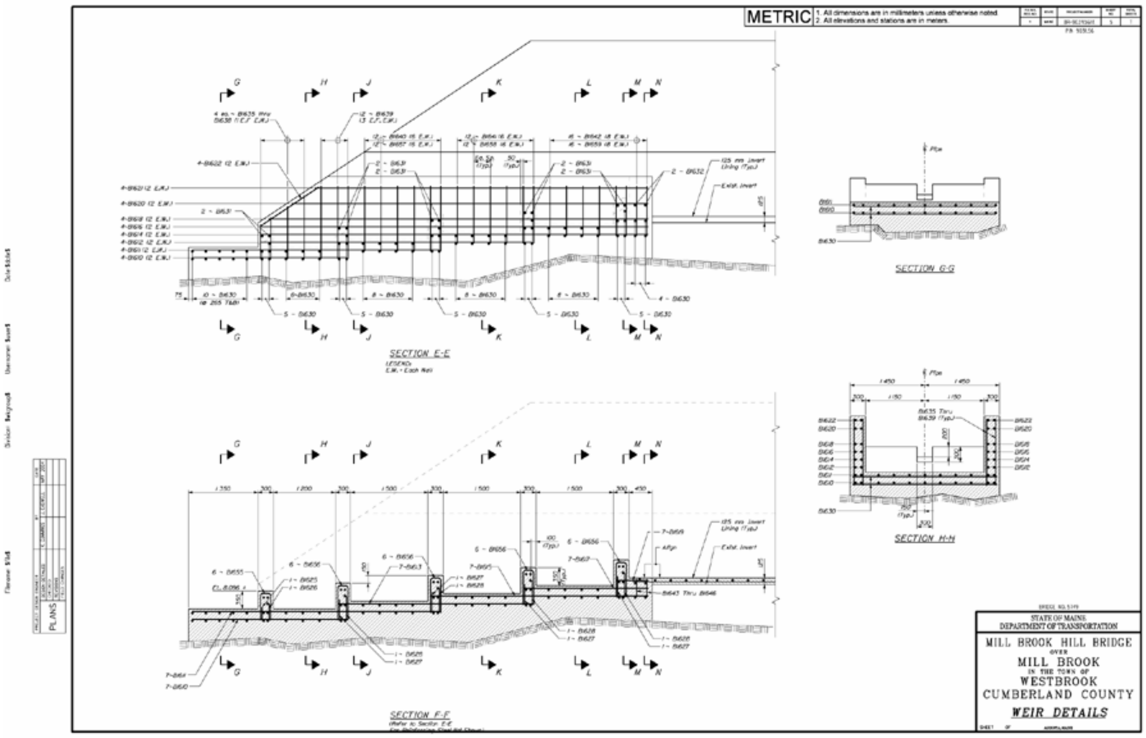

Figure 7-17 Weir Details Sheet 1

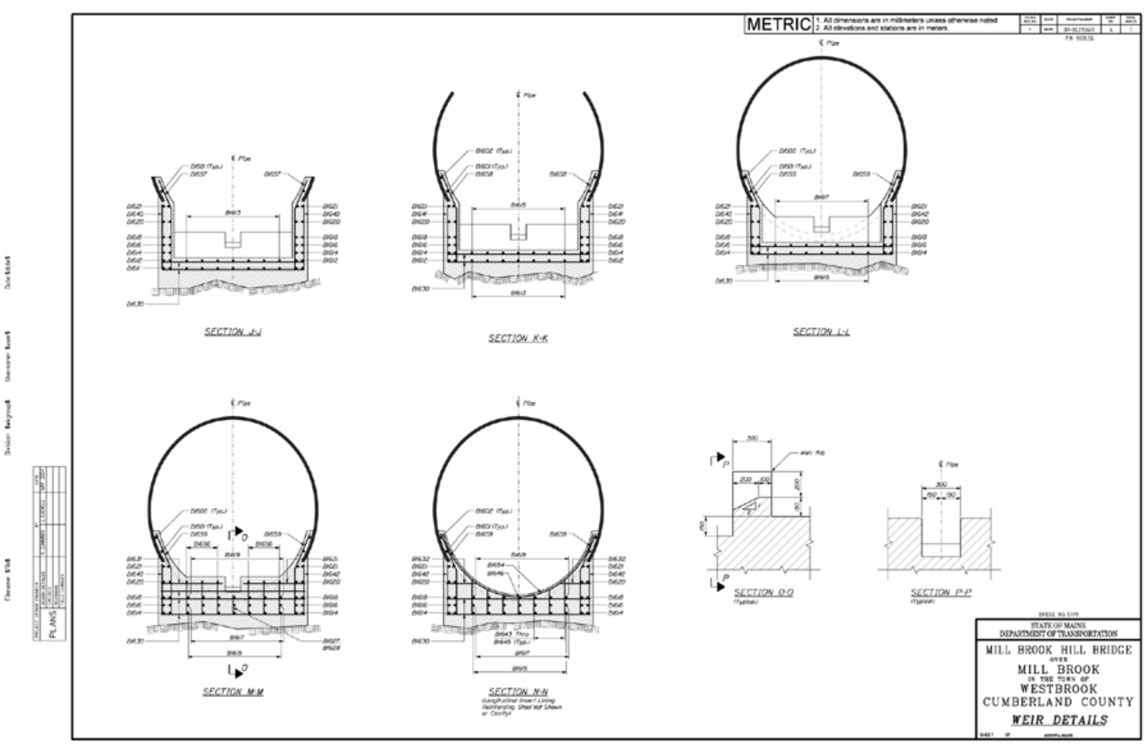

Figure 7-18 Weir Details Sheet 2

You may require more than one weir detail sheet, depending on how many sections you need to cut.

May Contain:

1) Weir Elevations
2) Weir Sections
3) Notes

7.6.6 Checklists

7.6.6.1 Structural Plan with Fish Weir

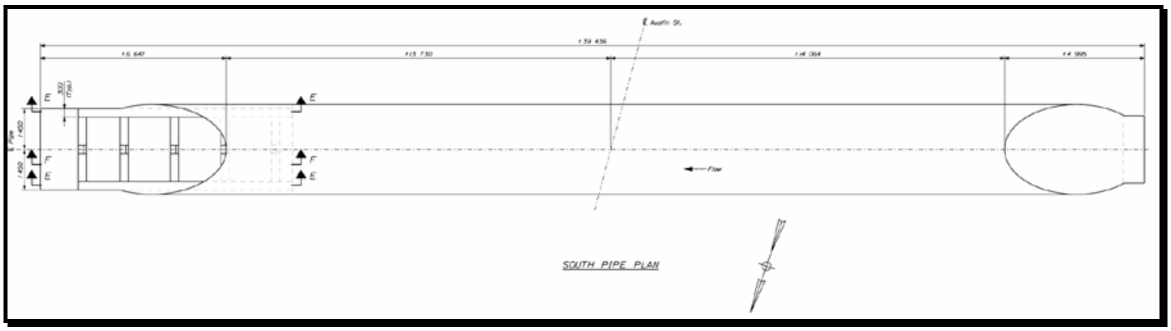

Figure 7-19 Structural Plan with Fish Weir

Intro: this may be the only plan view of the fish weir, and serves not only to orient the weir with the structure, but to show any and all information about the weir that requires a plan view.

Sheet up: belongs on the structural sheet

Scale: ¼"

Draw:

Refer to the requirements for the structure type accompanied by the weir. Add the following:

1) Fish Weir

Dimension:

Refer to the requirements for the structure type accompanied by the weir. Add the following:

1) Weir wall thickness

Label:

Refer to the requirements for the structure type accompanied by the weir. Add the following:

1) Weir section cuts

7.6.6.2 Structural Elevation with Fish Weir

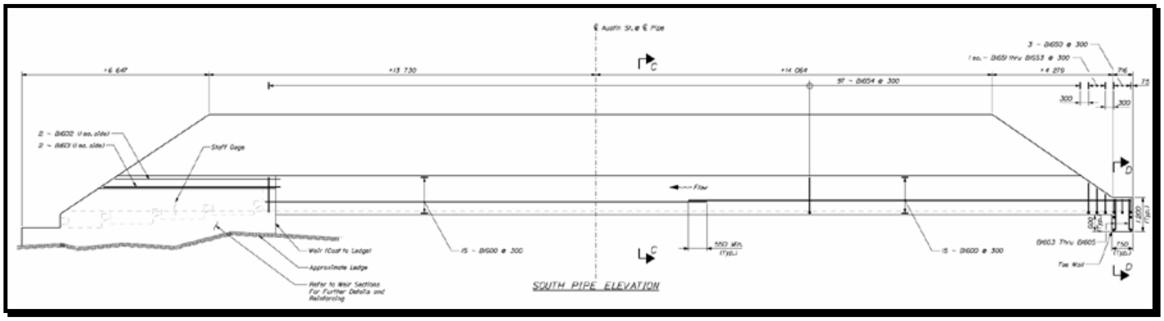

Figure 7-20 Structural Elevation with Fish Weir

Intro: this elevation shows the relationship between the weir and the structure.

Sheet up: belongs on the structural sheet

Scale: ½”

Draw:

Refer to the requirements for the structure type accompanied by the weir. Add the following:

1) Fish Weir
2) Reinforcing
3) Staff Gage

Label:

Refer to the requirements for the structure type accompanied by the weir. Add the following:

1) Weir
2) Reinforcing

7.6.6.3 Weir Elevations

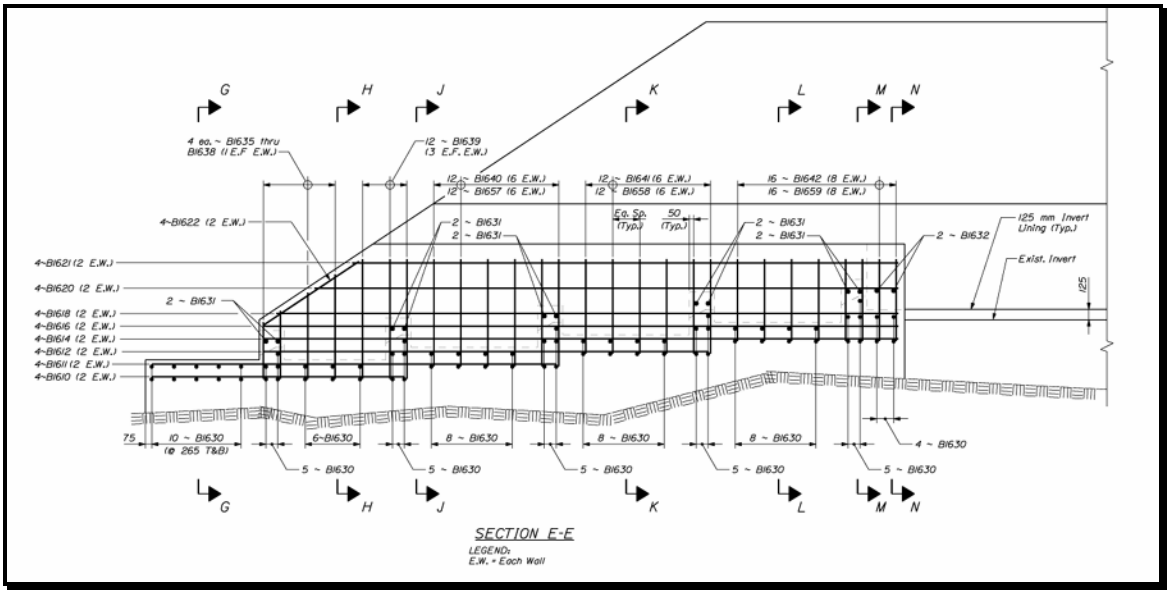

Figure 7-21 Weir Elevation 1

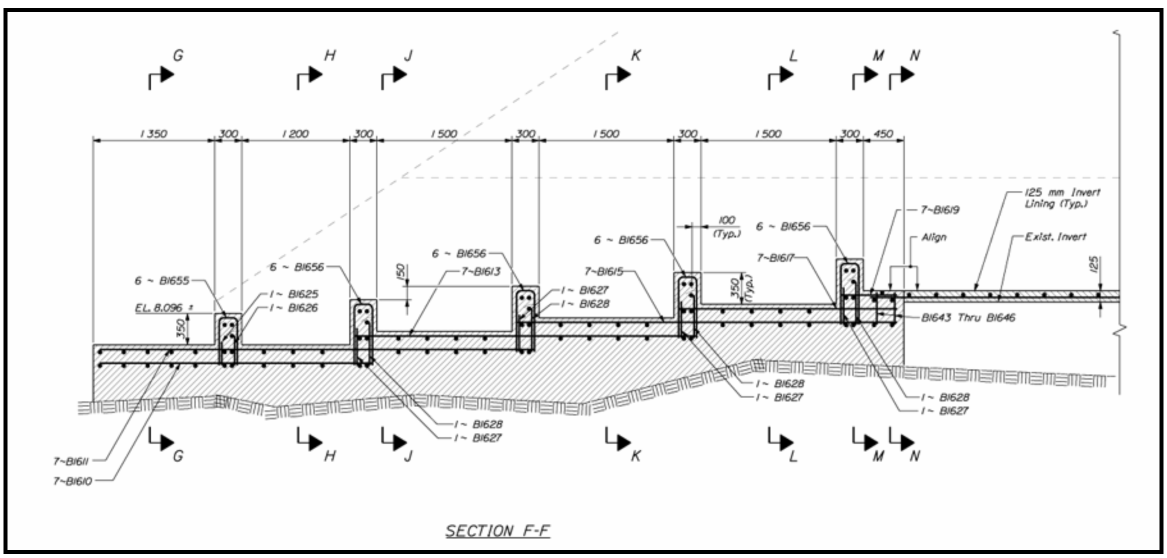

Figure 7-22 Weir Elevation 2

Intro: the weir elevations are really longitudinal sections cut to show the reinforcing steel. In the case of the sample project, two elevation were required, one to show the reinforcing in the walls, a second to show the reinforcing through the middle of the weir.

Sheet up: belongs on a weir details sheet.

Scale: ½" = 1'-0"

Draw:

1) Structure
2) Fish Weir

3) Reinforcing Steel
4) Ledge

Dimension:

1) Limits of concrete
2) Reinforcing Steel

Label:

1) Detail Name
2) Reinforcing Steel
3) Section Cuts
4) Ledge

7.6.6.4 Weir Section

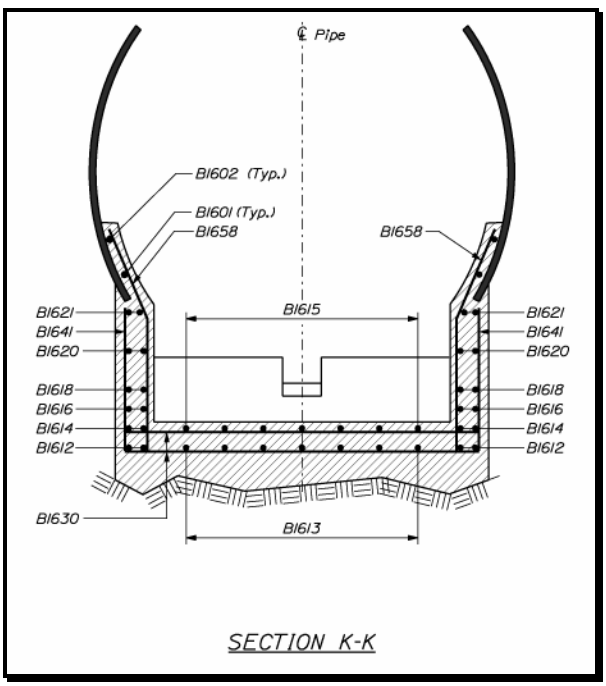

Figure 7-23 Weir Section

Intro: sections will be required to show the reinforcing steel along the limits of the weir.

Sheet up: belongs on a weir details sheet

Scale: ½" = 1'-0"

Draw:

1) CL Structure
2) Structure
3) Limits of Weir Concrete

4) Ledge
5) Reinforcing Steel

Dimension:

1) Reinforcing Steel

Label:

1) Label Name
2) CL Structure
3) Reinforcing Steel

7.6.6.5 Longitudinal Notch Section

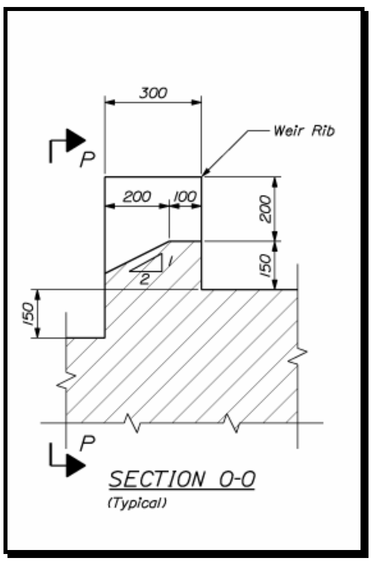

Figure 7-24 Longitudinal Notch Section

Intro: shows the typical notch geometry

Sheet up: belongs on a weir details sheet

Scale: 1" or 1½" = 1'-0"

Draw:

1) Limits of Concrete Weir Rib
2) Notch

Dimension:

1) Notch
2) Rib

Label:

1) Detail Name

2) Weir Rib
3) Notch Slope
4) Section Cut

7.6.6.6 Transverse Notch Section

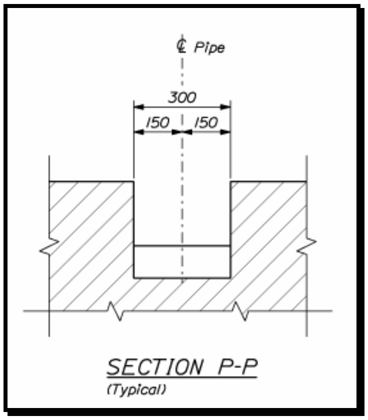

Figure 7-25 Transverse Notch Section

Intro: shows the typical notch geometry

Sheet up: belongs on a weir details sheet

Scale: 1" or 1½" = 1'-0"

Draw:

1) CL Pipe
2) Limits of Concrete Weir Rib
3) Notch

Dimension:

1) Notch Width

Label:

1) Detail Name
2) CL Structure

7.7 Bridge Deck Joints

7.7.1 Introduction

Bridge deck joints protect the bearing areas from corrosion and move with the structure. They come in every shape and size. It is common to rehabilitate the deck joint at the same time the wearing surface is replaced or rehabilitated.

7.7.2 Prerequisites

1) Assessment of the existing condition of the joint if it is to be rehabilitated. Measurements and locations of damaged areas. Pictures of the joint can be very useful.
2) Joint opening measurements taken in several different places along the joint, and the temperature recorded at the time the measurements were taken.
3) Joint Design (don't forget the curb or sidewalk area)
4) Joint welding information/design (if applicable)
5) Adjustment device design (if applicable)
6) Existing Plans (existing shop drawings of the joint may also be available)
7) Wearing surface thickness

7.7.3 Detailing

MaineDOT Standard Details take the place of most of the design related detailing on new projects. The lion's share of deck joint detailing happens when the structure is rehabilitated. There are so many variations of deck joints that it is impractical to show all of the examples here. It is very helpful to find an existing set of plans to go by. Flaws in new joint designs have a way of becoming more evident as it is being detailed. Be aware of conflicts around the curb and sidewalk plates and at the transition barrier. On skewed structures, check this area along the whole temperature range for potential projections that could cause problems for snow plows.

7.7.4 References

Bridge Program Deck Joint Technical Resource person

Bridge Design Manual

MaineDOT Standard Details

Bridge Program Technical Library

7.7.5 Checklists

- Plan
- Elevation
- North Arrow

- Skew Angle
- Designation of which end (location of seal)
- Cross-section
- Weld size and designation (symbols)
- Treatment of welds where seal passes over it
- Anchorage devices
- Location of seal bars (compression seal)
- Size of rolled steel members
- Notes

7.7.6 Armored Joint Notes

The following notes are required when using compression seals. A Compression Seal Adjustment Chart shall be shown on the plans – see page 1060(4) of the BDG

1) The seal(s) to be furnished shall have a minimum Movement Rating(s) as follows:

Abutment No. 1 = XX inch

Abutment No. 2 – XX inch

2) The Resident shall approve the seals prior to fabrication of the Expansion Device.

7.8 Lighting

7.8.1 Introduction

Occasionally a lighting system is required on a bridge. Here are some guidelines for detailing.

7.8.2 Prerequisites

You will require:

1) Finished superstructure structural plans
2) Light standard locations
3) Light standard anchorage system
4) Light standard utility requirements (conduits, junction boxes)
5) Lighting Notes

7.8.3 Detailing

Lighting details are explicit rather than performance-based. The Contractor is the chief client to consider when detailing.

7.8.4 Typical Sheet Names and Contents

7.8.4.1 Lighting Details

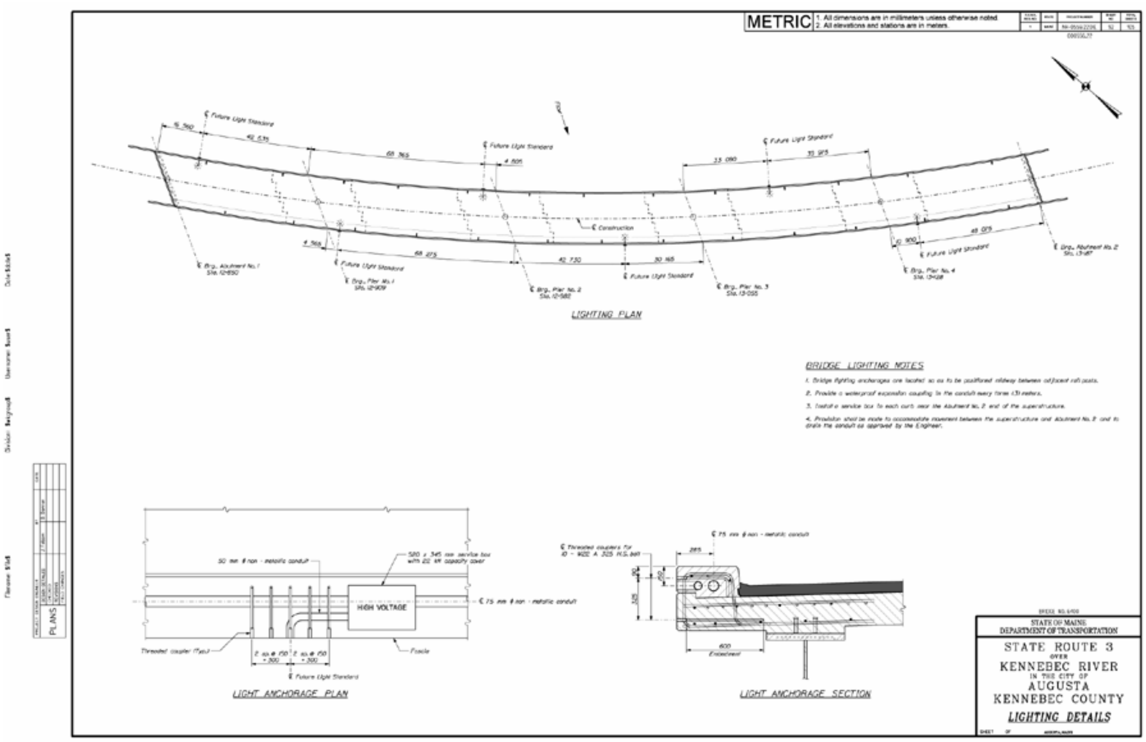

Figure 7-26 Lighting Details Sheet

Will Contain:

1) Lighting Plan
2) Bridge Lighting Notes
3) Light Anchorage Plan
4) Light Anchorage Section

May Contain:

1) Lamp Standard Details
2) Junction Box Detail

7.8.4.2 Lighting Plan

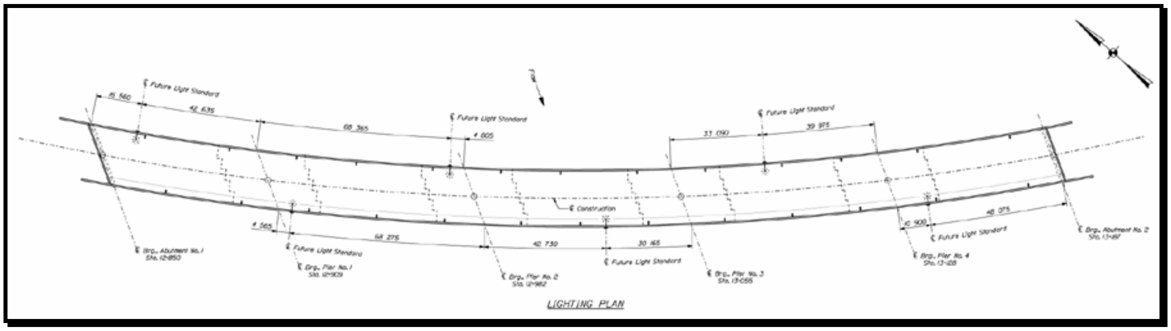

Figure 7-27 Lighting Plan

Intro: This plan shows the location of light standards in relation to working points along the superstructure.

Sheet up: belongs on Lighting Details Sheet at the top

Scale: 1”=25’, larger or smaller as req’d to fit on sheet

Draw:

1) CL Construction/Working Line
2) CL Light Standards
3) Limits of Concrete (& other superstructure details for perspective, i.e. curbs, sidewalks, bridge drains, etc.)
4) Light Standard
5) Expansion Joints

Dimension:

The working line for the purpose of locating light standards will be the fascia. Dimensions shall be given along the fascia for a curved bridge.

Working points will be the intersection of the substructure centerlines with the fascia.

1) Location of Light Standards
2) Expansion Joints

Label:

1) Detail Name “LIGHTING PLAN”
2) North Arrow
3) CL Construction
4) CL Brg. Substructures (with Station)
5) CL Light Standard
6) Expansion Joints

7.8.4.3 Light Anchorage Plan

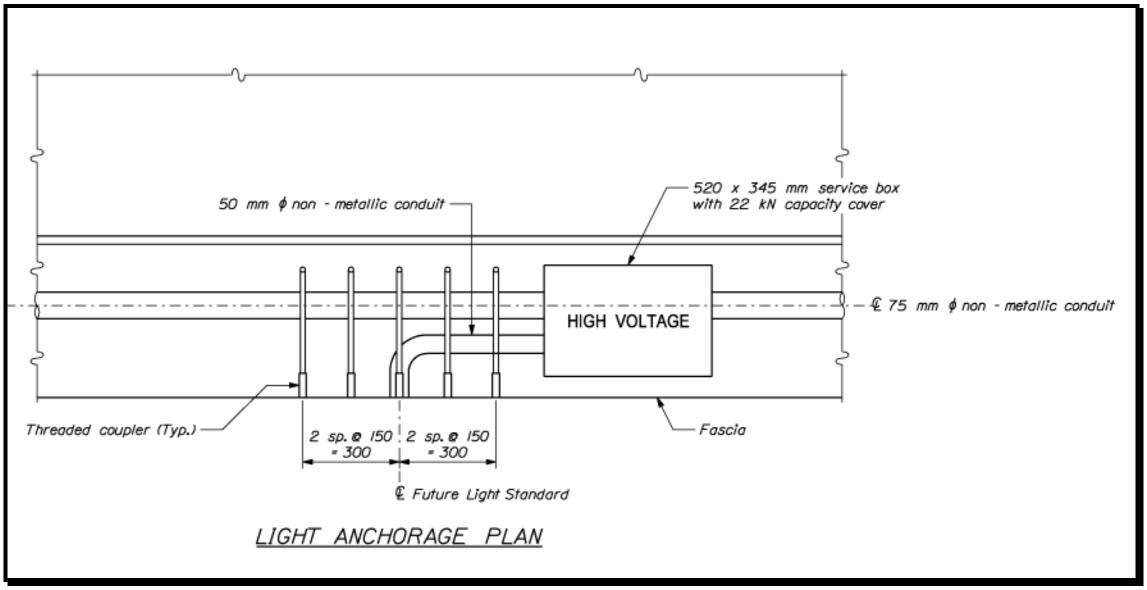

Figure 7-28 Light Anchorage Plan

Intro: the light anchorage plan shows the structural anchorage, utility conduits, and service boxes required to support the lighting system.

Sheet up: belongs on lighting details sheet, below plan

Scale: 1"=1'-0"

Draw:

1) CL Light Standard
2) CL Utility Conduits
3) Fascia
4) Face of Curb
5) Utilities
6) Reinforcing Steel/Anchorages

Dimension:

1) Location & Spacing of Reinforcing/Anchorage

Label:

1) Detail Name ("LIGHT ANCHORAGE PLAN")
2) CL Light Standard
3) CL Conduits
4) Utilities
5) Reinforcing Steel/Anchorage

7.8.4.4 Light Anchorage Section

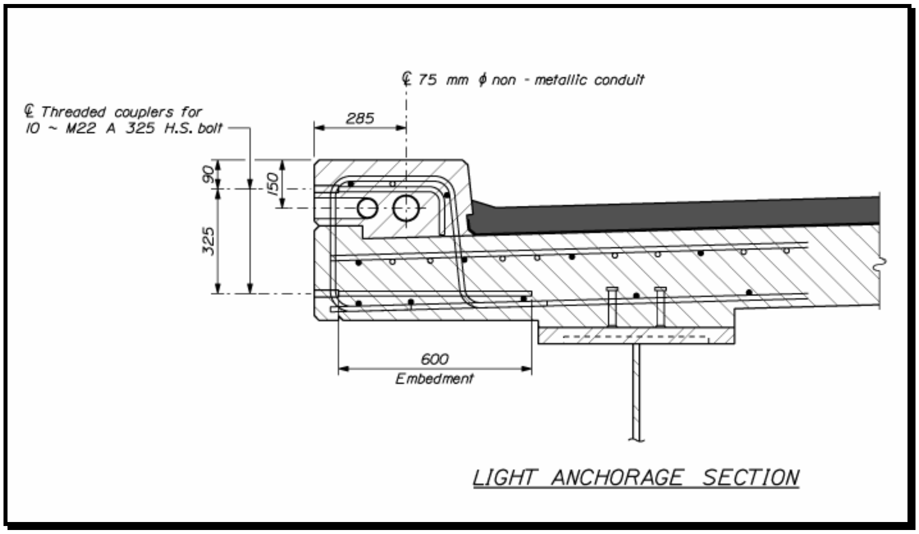

Figure 7-29 Light Anchorage Section

Intro: transverse section of the structural anchorage, utility conduits, and service boxes required to support the lighting system.

Sheet up: belongs on lighting details sheet below plan and to the right of light anchorage plan

Scale: 1”=1’-0”

Draw:

1) CL Conduits
2) Transverse section of the slab near the fascia, including
   a) Limits of concrete deck
   b) Wearing surface
   c) Curb
   d) Outer beam
3) Reinforcing/Anchorage
4) Utilities

Dimension:

1) Location of Conduits, tied to limits of concrete
2) Location and Embedment of Reinforcing/Anchorage

Label:

1) Detail Name (“LIGHT ANCHORAGE DETAIL”)
2) CL Conduits

7.9 Utilities

7.9.1 Introduction

When utilities are attached to bridges we are sometimes called upon to develop some unique support systems and details. Often time's utility conduits are cast into concrete sidewalks or curbs, or externally attached to the superstructure, and pass through the substructure.

7.9.2 Prerequisites

1) Utility support design or conceptual sketches
2) Proposed Utility location/elevations

7.9.3 Detailing

Sometimes the details are explicit and sometimes they are more performance based. If for example, the support system is a steel support that is attached to the concrete deck, then the utility company is usually responsible for designing the support systems, and MaineDOT usually will show some performance based conceptual drawings on the plans. If the support system is integral with the concrete in the bridge structure, then the detailer may end up developing more explicit details.

7.9.4 Checklists

7.9.4.1 Utility Between Box Beams

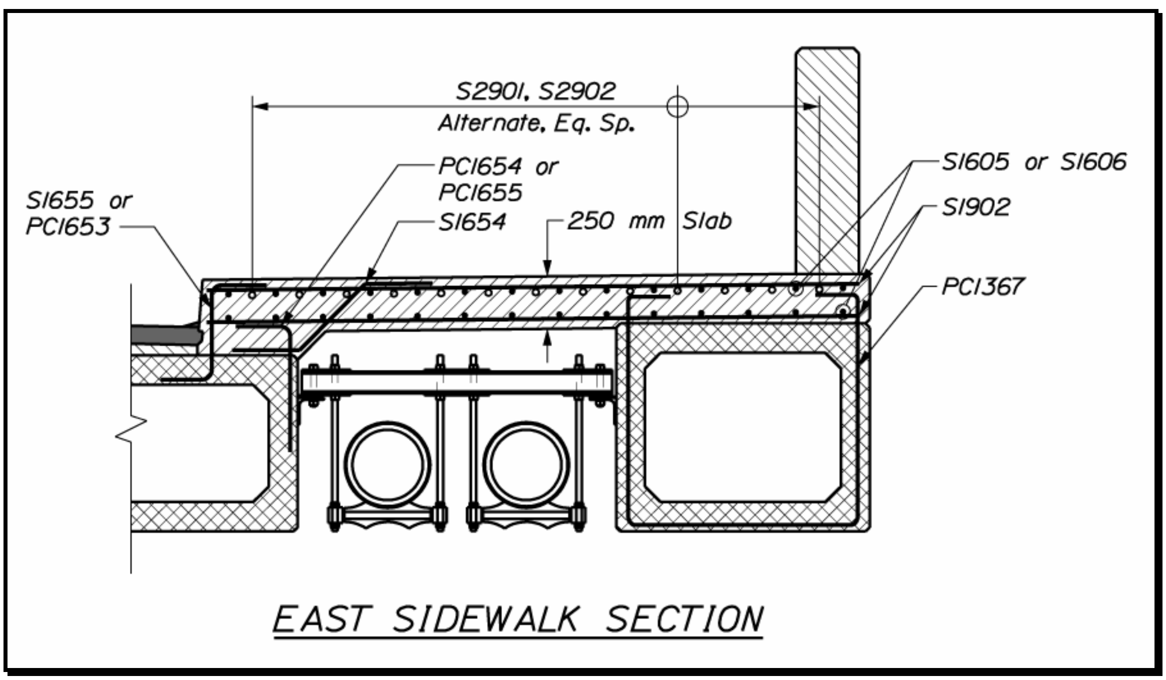

Figure 7-30 Utility Between Box Beams

Intro: This support system involves supporting water mains from hangers. These hangers suspend from a diaphragm that is anchored into precast concrete box beams. The section shown is provided to show sidewalk reinforcement. It is also a good section to diagrammatically show the relationship between the utility and the superstructure

Sheet up: this section is shown on a superstructure details sheet.

Scale: ½" = 1'-0"

Draw:

1) Superstructure
2) Water Main
3) Water Main Support

7.9.4.2 Utility Between Box Beams at Abutment

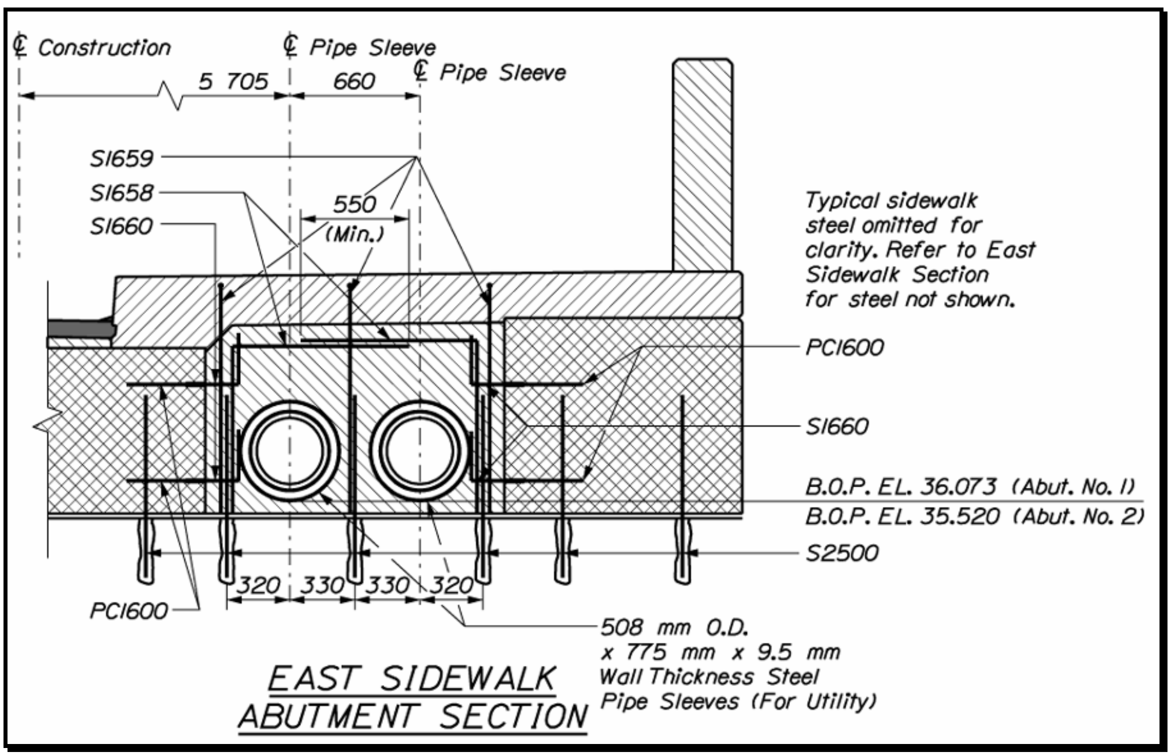

Figure 7-31 Utility Between Box Beams at Abutment

Intro: this utility system requires the construction of a diaphragm of concrete at the abutment. It requires reinforcing steel, anchors/dowels, and pipe sleeves. A similar section is required to show reinforcing at the pier.

Sheet up: this transverse section was shown on a superstructure details sheet.

Scale: ½" = 1'-0"

Draw:

1) Utility

2) Pipe Sleeves
3) Reinforcing Steel
4) Limits of Superstructure concrete
5) Limits of Abutment Concrete

Dimension:

1) Utility Location (in relation to reference lines when possible)
2) Reinforcing Steel

Label:

1) Utility
2) Reinforcing Steel
3) Bottom of Utility Elevation

7.9.4.3 Threaded Inserts in Precast Concrete

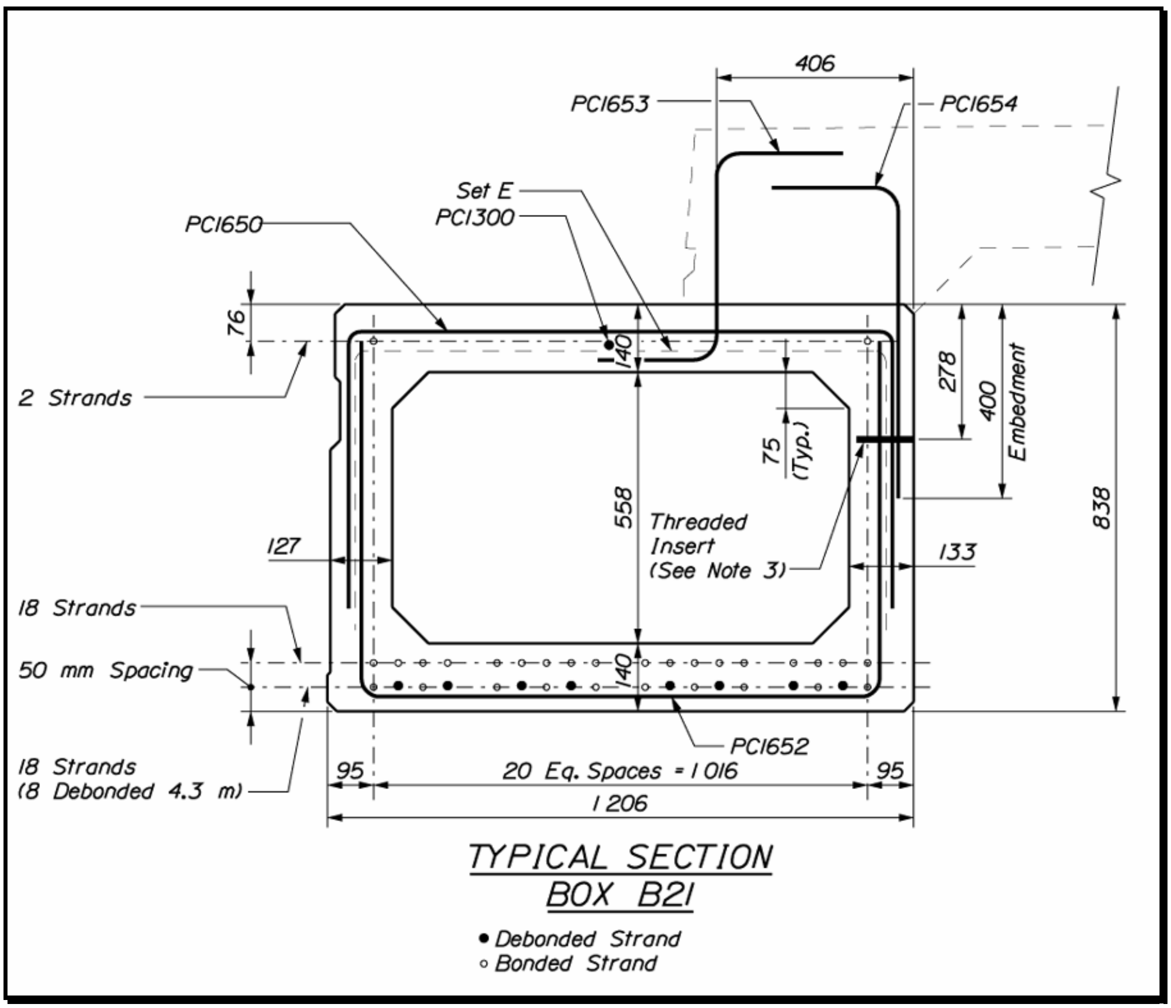

Figure 7-32 Threaded Inserts in Precast Concrete

Intro: utilities supported on precast concrete may require threaded inserts into the precast. These need to be clearly shown on the precast details.

7.9.4.4 Utility on Exterior Box Beam

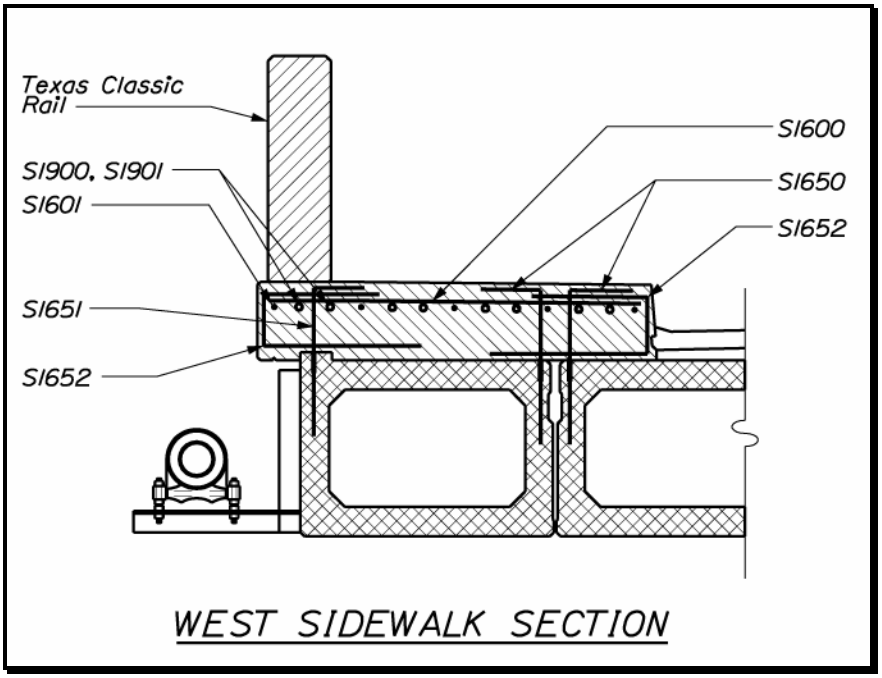

Figure 7-33 Utility on Exterior Box Beam

Intro: Utilities may be supported outside the fascia. This example supports the utility on rollers that set on a steel angle. A similar system might support the utility on a roller that is held up by hangers suspended from an angle. The detail shown is provided to show sidewalk reinforcement, but it is a good place to diagrammatically show the relationship between the superstructure and the utility.

7.9.4.5 Utility Penetrating Abutment

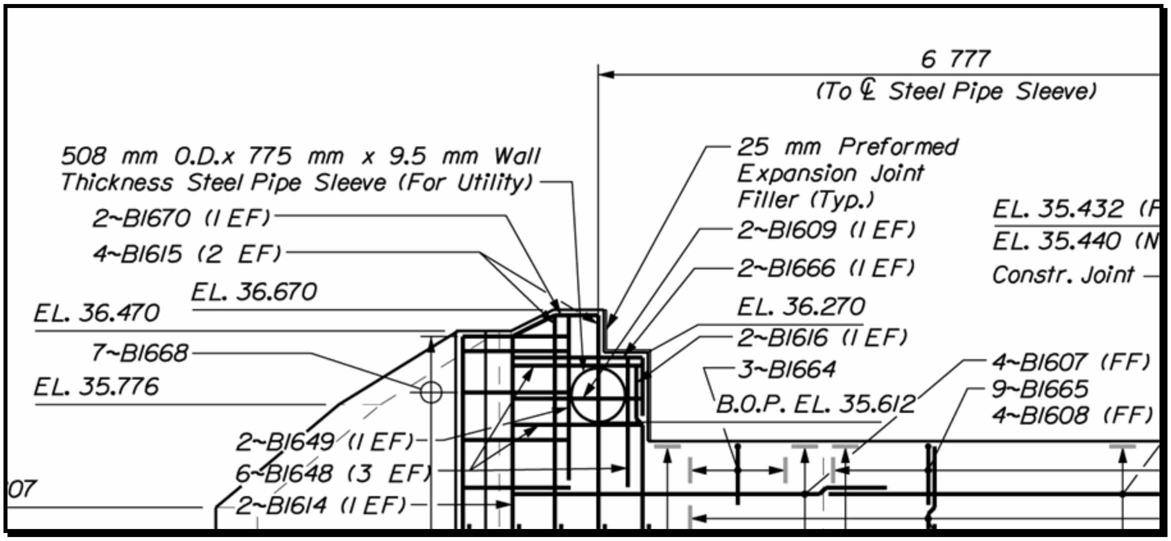

Figure 7-34 Utility Penetrating Abutment

Intro: the utility penetration through the abutment needs to be shown on the abutment elevation. Show and label any required sleeves, dimension the centerline of sleeve and label the elevation of the bottom of the sleeve. Reinforcing steel needs to be added around any penetrations to compensate for steel that is cut to make room for the utility.

7.10 Addendums to the Plans

7.10.1 Introduction

Occasionally revisions need to be made to the plans after the contract has been advertised. Typically this happens when one of the bidders brings a concern about the plans to the Project Manager. Sometimes the problem can be remedied by an addendum to the contract book. Other times the change needs to be on the plans. When this happens, the addendum needs to be tracked. This is done by numbering and dating the addendum.

7.10.2 Typical Sheet Names and Contents

Create a duplicate of the sheet that is to be revised. (Keep the original sheet for future reference.) The new file name should reflect the addendum revision number. The new sheet designation can be made by adding a letter suffix to the original sheet number. (If the original sheet was number 3, then the revised sheet will be 3A.) The new sheet will usually contain the original information that still pertains, with the revisions shown in addition.

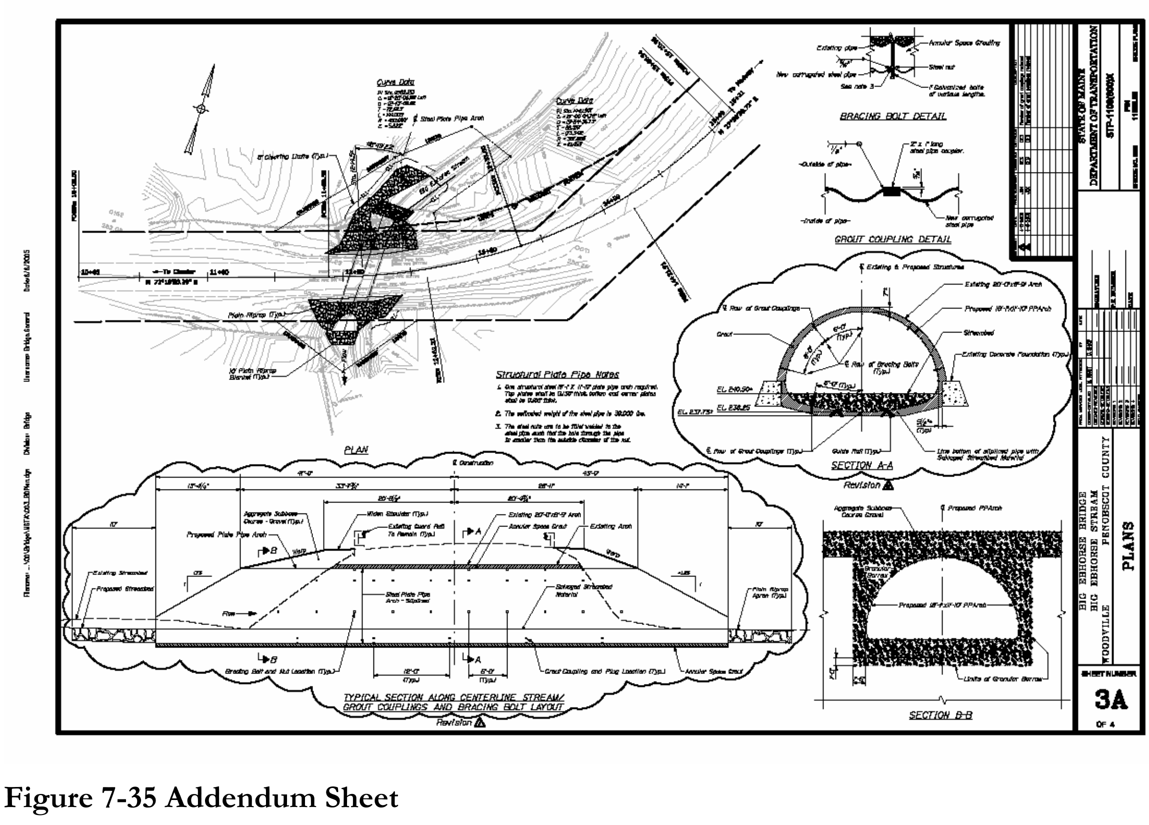

Figure 7-35 Addendum Sheet

7.10.3 Detailing

Put the addendum number in a triangle (approximately ¼" high) next to the new/revised detail or dimension. To bring attention to the revision, draw a cloud around it. Create a revision block next to the sheets title block. The revision block shall contain the revision number, the date, the initials of the project manager, the designer, the technician and a description of what was changed.

REVISION	DATE	PROJ. MANAGER	DESIGNER	DETAILER	DESCRIPTION
△1	4-6-2005	JCK	DES	DES	Number of grout couplings reduced
△2	4 6 2005	JCK	DES	DES	Number of grout couplings reduced

Figure 7-36 Revision Block

> ⓘ **The revised sheet will need to be distributed to all of the bidders and filed with the original plans.**

7.11 Hearing Plans

7.11.1 Introduction

Hearing plans are essentially a form of preliminary plans that have been enhanced (colored) for the public participation process. There are three types of public hearings, the informational hearing, the preliminary hearing, and the formal hearing. The preliminary and formal hearings are standard fare. The informational hearings happen less frequently.

Hearing plans on ordinary projects will be the responsibility of the team in the Bridge Program. Special projects such as extra large projects, photographic displays, animated or aerial displays may be done by the Office of
Communications.

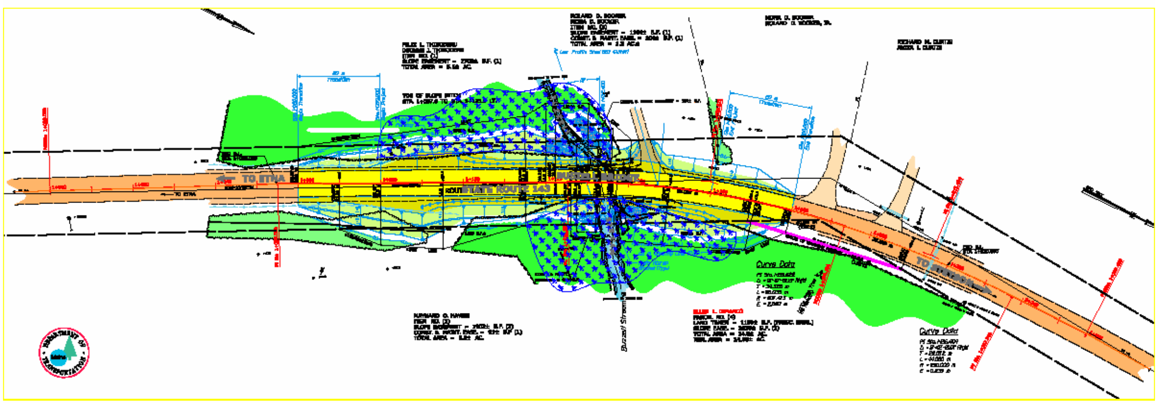

Figure 7-37 Hearing Plan

7.11.2 Prerequisites

To begin developing the Preliminary Public Hearing Plan the detailer needs the following:

1. Survey
2. Location Map

To begin developing the Formal Public Hearing Plans the detailer needs the following:

1. Proposed Plan
2. Proposed Profile
3. Typical Existing Bridge Section
4. Typical Proposed Bridge Section
5. Typical Proposed Approach Section
6. Location Map

7. Staged Construction Sequence (when appropriate)
8. Title Block Information

7.11.3 Detailing

The enhancement of the preliminary plans for public meeting consists of coloring the plans using the MaineDOT standard hearing plan colors, making some of the key text bold so that it is readable from a distance by people at the public meeting, and attaching the details to a backing for display at the meeting. Be sure to show all limits and impacts on your plan so that all interested parties at the public meeting can view what applies to them. Refer to the approach plan section of this guide for a detailed list.

7.11.3.1 Bold Text

Here is a list of text that should be bold.

1. Titles
2. Road Name/Route Number
3. To Town Name→
4. Waterway Name
5. Title Block Information
6. Any other special item that needs to stand out

7.11.3.2 Color Reference

Use the following charts to reference when coloring the details. They are broken into three categories, plan, profile and typical sections.

PLAN LEGEND

NOTE:ALL PATTERNING SHOULD BE DONE LAST

color no.	color & level	level	PROPOSED	color no.	color & level	level	EXISTING
0		0	SYMBOLOGY LEVEL	115		32	E:TRAVELWAY
6		1	P:TRAVELWAY	116		33	E:SHOULDERS
253		2	P:SHOULDER,paved	117		34	E:DRIVES & PARKING LOTS
180		3	P:SHOULDER,gravel	21		35	E:BUILDINGS
253		4	P:DRIVES,PAVED	118		36	E:ISLANDS
180		5	P:DRIVES,GRAVEL	22		37	E:SIDE:WALKS ROCKS/CONCRETE WALLS
253		6	P:PAVED:APRON	109		38	TREES, CONIFEROUS
19		7	P:SIDEWALKS	39		39	TREES, DECIDUOUS
244		8	P:SLOPE:GRASS	56		40	WOODS
40		9	P:ISLANDS,RAISED	59		41	BRUSH
229		10	P:ISLANDS,FLUSH	243		42	BUSH & SHRUBS
106		11	WETLANDS-MITIGATED	151		43	WATER1
2		12	BLDS.,TREES ALL REMOVED	153		44	WATER2
38		13	CUT SLOPE LINE	155		45	WATER3
5		14	FILL SLOPE LINE	156		46	WATER4
2		15	CENTER LINE	157		47	WATER5
30		16	R/W LINE	167		48	WATERWAYS DEVERTED, ALL
1	TEXT	17	TEXT	72		49	EXISTING, WETLANDS use this pattern to fill wet lands
1		18	LANE LINES	182		50	E:WOOD:WALLS
1		19	DIRECTIONAL ARROWS	230		51	E:GARDENS
27		20	P:SUB:GRADE:FILL	7		52	E:CENTER:LINE
240		21	P:BRIDGE:STEEL	113		53	E:BRIDGE:DECK
242		22	" " "	20		54	E:LEDGE use this pattern to fill ledge areas
244		23	" " "			55	
176		24	P:BRIDGE:WOOD	30		56	FOR SYMBOLOGY
26		25	" " "	31		57	FOR SYMBOLOGY
25		26	" " "	3		58	FOR SYMBOLOGY
18		27	P:CONCRETE	135		59	FOR SYMBOLOGY
17		28	" "	8		60	FOR SYMBOLOGY
16		29	" "	9		61	FOR SYMBOLOGY
136		30	PROPOSED TREES	1		62	**FOR SYMBOLOGY (TEXT)**
133		31	PROPOSED DETOURS	1		63	

Figure 7-38 Color Chart for Plan View

PROFILE LEGEND

color no*	color & level	level	PROPOSED	color no*	color & level	level	EXISTING
176		38	P:SUB:GRADE:FILL-1	180		3	E:WOOD:BRIDGE-1
178		39	P:SUB:GRADE:FILL-2	181		4	E:WOOD:BRIDGE-2
180		40	P:SUB:GRADE:FILL-3	182		5	E:WOOD:BRIDGE-3
240		21	P:BRIDGE:STEEL-1	244		8	E:STEEL:BRIDGE-1
242		22	P:BRIDGE:STEEL-2	245		9	E:STEEL:BRIDGE-2
244		23	P:BRIDGE:STEEL-3	246		10	E:STEEL:BRIDGE-3
176		24	P:BRIDGE:WOOD-1	20		35	E:CONCRETE:BRIDGE-1
26		25	P:BRIDGE:WOOD-2	21		36	E:CONCRETE:BRIDGE-2
25		26	P:BRIDGE:WOOD-3	22		37	E:CONCRETE:BRIDGE-3
18		27	P:BRIDGE:CONC-1	151		43	WATER-1
17		28	P:BRIDGE:CONC-2	153		44	WATER-2
16		29	P:BRIDGE:CONC-3	155		45	WATER-3
2		15	P:CENTER:LINE	156		46	WATER-4
1	TEXT	17	TEXT	157		47	WATER-5
1		18	LANE LINES	115		32	E:GROUND-1
1		19	DIRECTIONAL ARROWS	116		33	E:GROUND-2
6		20	DIRECTIONAL ARROWS	117		34	E:GROUND-3
				118		55	E:GROUND-4
				7		52	E:CENTER:LINE
				113		53	E:BRIDGE:DECK
				1		62	**FOR SYMBOLOGY (TEXT)**
				1		63	LINES

Figure 7-39 Color Chart for Profile

TYPICAL LEGEND

color no*	color & level	level	PROPOSED	color no*	color & level	level	EXISTING
6		1	P:TRAVELWAY	180		3	E:WOOD:BRIDGE
253		2	P:SHOULDER,paved	181		4	E:WOOD:BRIDGE
180		6	P:SHOULDER,gravel	182		5	E:WOOD:BRIDGE
19		7	P:SIDEWALKS	244		8	E:STEEL:BRIDGE
40		11	P:ISLANDS,RAISED	245		9	E:STEEL:BRIDGE
229		12	P:ISLANDS,FLUSH	246		10	E:STEEL:BRIDGE
176		38	P:SUB:GRADE:FILL	20		35	E:CONCRETE:BRIDGE
178		39	" " "	21		36	E:CONCRETE:BRIDGE
180		40	" " "	22		37	E:CONCRETE:BRIDGE
240		21	P:BRIDGE:STEEL	151		43	WATER1
242		22	" " "	153		44	WATER2
244		23	" " "	155		45	WATER3
176		24	P:BRIDGE:WOOD	156		46	WATER4
26		25	" " "	157		47	WATER5
25		26	" " "	115		32	E:GROUND
18		27	P:CONCRETE	116		33	E:GROUND
17		28	" "	117		34	E:GROUND
16		29	" "	118		55	E:GROUND
2		15	P:CENTER:LINE	7		52	E:CENTER:LINE
244		13	P:SLOPE:GRASS	113		53	E:BRIDGE:DECK
1	TEXT	17	TEXT	1		62	**FOR SYMBOLOGY (TEXT)**
1		18	LANE LINES	1		63	
1		19	DIRECTIONAL ARROWS				

Figure 7-40 Color Chart for Sections

7.11.3.3 Background Sheet

Hearing plan details are displayed on a plain white paper background sheet. Details can be all printed on one sheet, or printed separately and then taped onto the background. This way if there is a small error on one detail, one does not have to plot out another long sheet to fix it. If there is room on the sheet, place the plan directly over the profile so that the viewer can see the relationship between the two. The title block is usually placed in the lower right hand corner. The other details can be placed wherever they fit best.

> ⓘ **Any plans or display that goes to a public hearing becomes a legal document that must be electronically archived for six years. If the plans are written on at the public meeting, the hard copy must be scanned and archived.**

7.11.4 References and Resources

MaineDOT Microstation Manual

CADD Cell Library and Settings Manager

H:\$Common-Bridge\Technician Tools

Office of Communication – Hearing Plan Specialists

7.12 Coast Guard Permitting

CHAPTER 8 REINFORCING STEEL

8.1 Table of Contents

CHAPTER 8 REINFORCING STEEL 8-1

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8.2 Overview

The purpose of this chapter is to provide you with a solid introduction to reinforcing steel. There are a couple of acceptable approaches to reinforcing detailing. There are also some important habits, practices, and techniques that will help your detailing of rebar go much smoother. What follows this overview is a recommended method that ought to give you a starting point and a sense of perspective.

> ⓘ **Remember that your primary goals are accuracy, clarity, organization and consistency. It is critical to get the reinforcing steel drawn and scheduled correctly. It is important to clearly communicate the design intent to the Contractor. Finally, it is helpful to everyone if the reinforcing steel is organized and the plans are detailed in a consistent way, job to job and sheet to sheet.**

8.2.1 Why Reinforce Concrete?

Concrete is a relatively inexpensive material that is both resistant to corrosion and strong in compression but unable to resist strong tensile forces. You could say that concrete resists being pushed, but fails when it is pulled. Reinforcing steel helps resist those tensile or "pulling" forces.

♬ Reinforcing steel in columns, unlike most reinforcing steel, acts not only to resist tensile forces, but also compression.

Reinforced concrete gets its strength from the two materials, steel and concrete, working together. To get them working together, it is critical that the steel be adequately bonded to the concrete. Achieving this bond is called **developing** the bar, and many aspects of reinforcing design are geared toward achieving development.

8.2.2 Types of Reinforcing

8.2.2.1 Main Reinforcing

Main reinforcing are the bars that are in place to resist the forces that would otherwise pull the concrete apart.

[insert graphic to demonstrate where tensile forces occur, typical main reinforcement]

8.2.2.2 Shrinkage and Temperature Reinforcing

A shortcoming of concrete is that it tends to crack as it cures and as it expands and contracts with change of temperature. Shrinkage and temperature reinforcing minimizes this cracking and typically runs perpendicular to the main reinforcing.

8.2.2.3 Distribution Reinforcing

Distribution reinforcing takes a concentrated load and spreads it over more area to engage more of the structure to carry the load. This reinforcing typically runs perpendicular to the main reinforcing.

8.2.2.4 Shear Reinforcing

Shear reinforcing typically runs perpendicular to the main reinforcing and is generally concentrated around points where the concrete is being supported. The combination of forces at these locations tends to break the concrete diagonally. Shear reinforcing resists that diagonal breakage.

- ♬ Shear reinforcing would be most efficiently placed diagonally, perpendicular to the direction of cracking. It is placed normal to the main steel chiefly for constructability reasons.

Typical places you would find shear reinforcing would be in a superstructure where it is supported at abutments and piers or in a pier cap where it is supported by columns.

8.2.2.5 Superstructure Over Pier

There is also reinforcing steel in some superstructures in the area over the pier. This "Additional Distribution Reinforcement" minimizes cracking over the pier.

- ♬ Technically, this steel also resists bending in the negative moment region as well, though this is not the reason the steel is placed here.

8.2.3 Some Reinforcing Concepts

8.2.3.1 Developing a Bar

The strength of reinforced concrete comes from the composite action of the two materials. Developing a bar means creating the necessary bond between the steel and the concrete. A properly developed bar will yield before it pulls out of the concrete.

8.2.3.2 Cover

Steel rusts, concrete doesn't. "Cover" is how much concrete is required to cover the steel to help keep it from rusting. It is measured from the face of concrete to the face of steel.

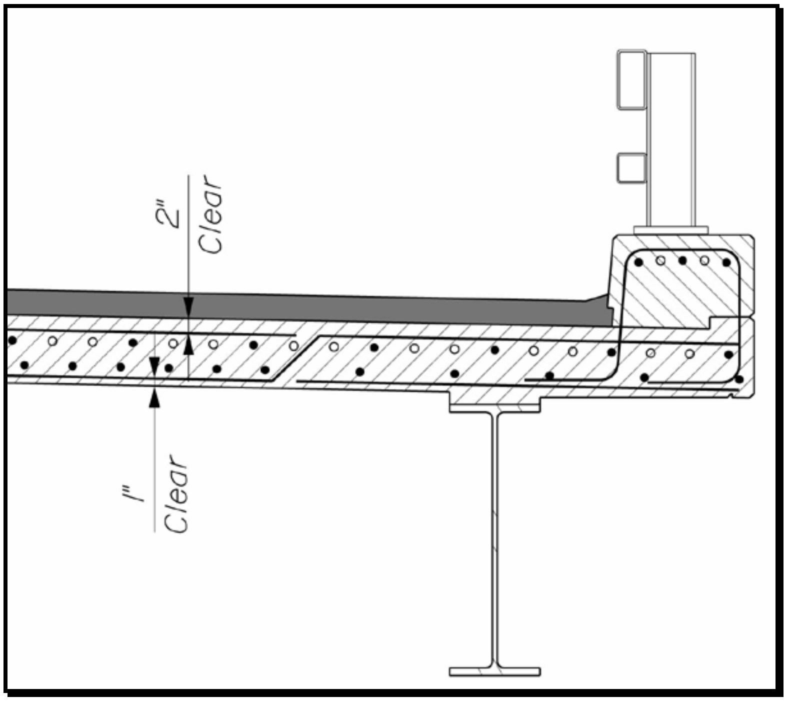


Figure 8-1 Cover Requirements in Superstructure

Cover varies depending on how much environmental exposure a surface gets. Tops of superstructures require more cover than bottom sides, abutment footings require more cover than breastwalls. Salt-water structures require more cover.

Cover also varies with constructability issues. Concrete surfaces cast against soil or ledge require more cover, due to the irregularity of the surface.

Cover is specified by the designer according to AASHTO.

♬ Cover is always specified as a minimum. Bars placed with too little cover may end up rusting, so why not bury the bars deeper? That might reduce the strength of the structure. Think of the bars on opposite sides of a slab as being the flanges of a beam. Burying the bars too deep is like reducing the depth of that beam.

8.2.3.3 Embedment

Rebar gets its strength by bonding to concrete. Embedment is the minimum length of steel that has to be encased in concrete to develop the required strength. Embedment length varies with bar size, pullout strength, concrete strength, and structural requirements.

You will often deal with embedment lengths when looking at how far bars need to extend into a footing, or between two separate placements of concrete.

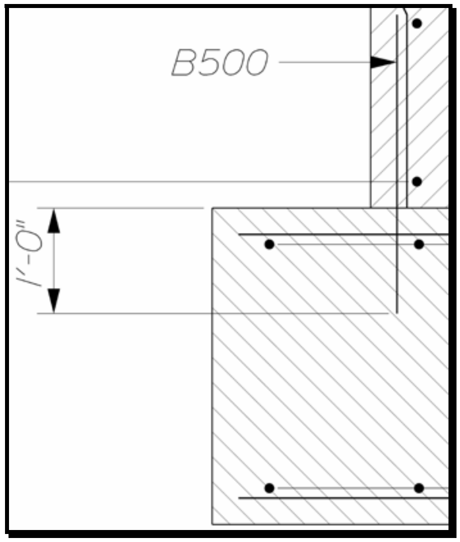


Figure 8-2 Dowel Embedment

8.2.3.4 Hooks

Sometimes there isn't enough depth of concrete to provide enough embedment to develop strength. Another way to develop strength of the bar is to bend the end of the bar into a hook. Hooks can be of different angles, and the bend radius varies both with hook type and with size of steel.

♬ Hooked bars can develop more strength in less space than straight bars.

One common use of hooked bars is to force a contractor to place certain bars prior to placement of concrete, i.e. vertical steel coming out of an abutment footing. A straight dowel might be pushed into freshly placed concrete, which weakens the bond around the bar.

Hooks can be enclosed or non-enclosed. The enclosure of a hook affects the embedment required.

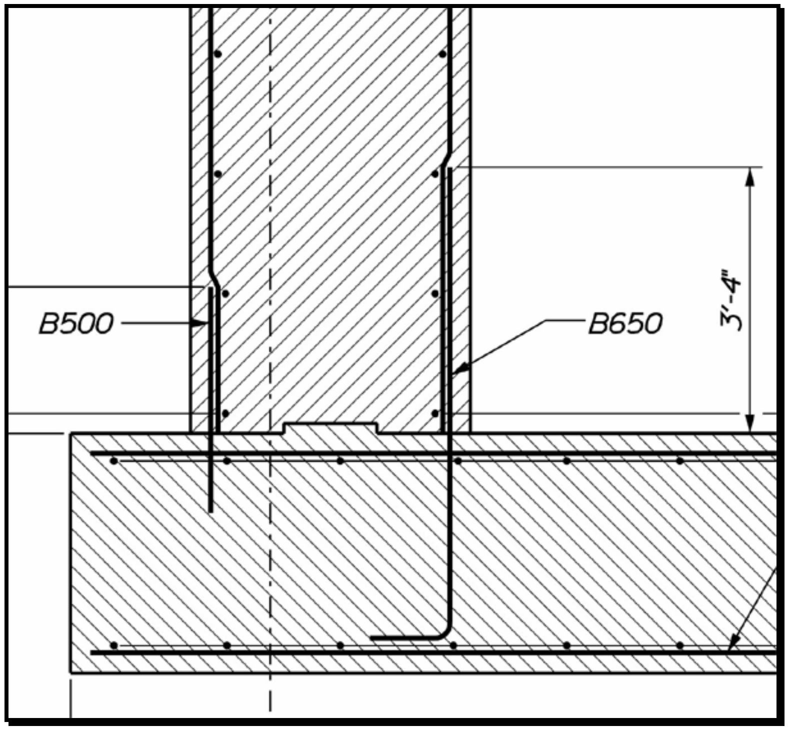


Figure 8-3 Unenclosed Hook

(Note that there are no longitudinal bars directly over the hook.)

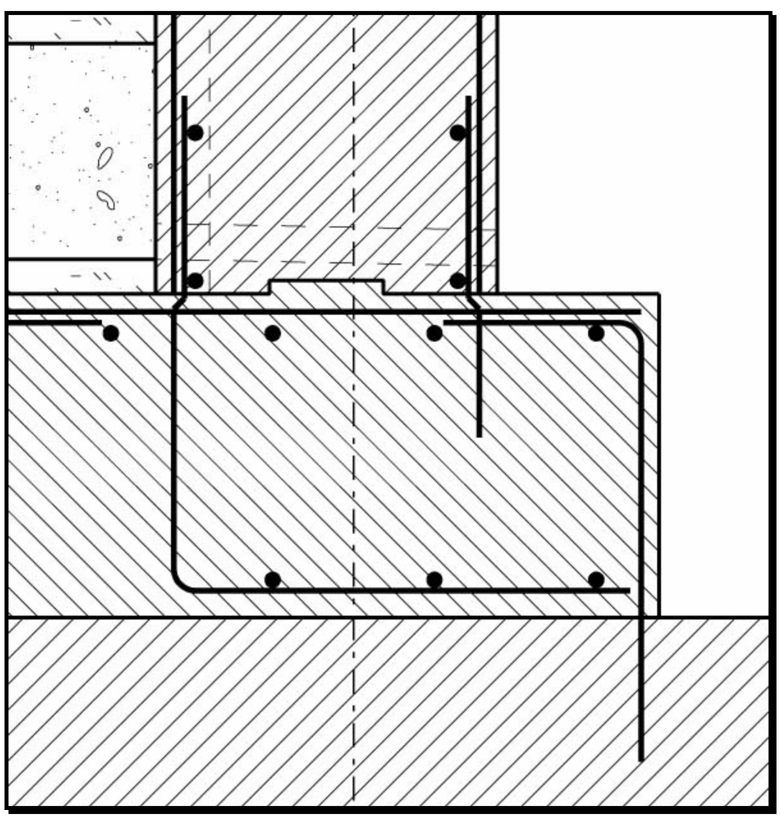


Figure 8-4 Enclosed Hook

8.2.3.5 Splices

Splicing is required when a bar isn't long enough or a joint is required. Bars may be deliberately left short for constructability and transportation concerns.

A. Lap Splices

The preferred method of splicing two bars together is a lap splice, where the two bars overlap each other for some minimum distance. This distance is the splice length.

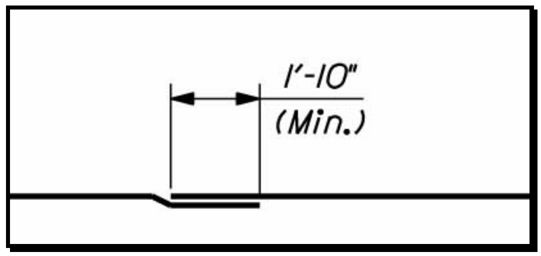


Figure 8-5 Splice Length

♬ The "kink" in the bar on the left of Figure 8-5 is a symbol to indicate that the two bars are in physical contact and wired together. It does not represent an actual bend in the bar.

Tie wires on splices are used to hold the bars in position. The strength of the lap splices comes from the bond of the bars to the surrounding concrete, not from the tie wire.

The splice length varies depending on the size of the bars, epoxy coating, strength of the concrete, and the structural requirements. Splice lengths should be specified by the designer.

B. Mechanical Couplers

It is sometimes necessary to attach bars together without the benefit of a lap splice. This requirement may arise due to geometric or constructability constraints. In cases where a splice is required, but a lap splice cannot be fit, a mechanical coupler may be used.

Mechanical couplers provide a physical connection between two bars. This is shown diagrammatically as in Figure 8-6 Mechanical Coupler.

Refer to Standard Specifications Section 503.07 for more information on splicing.

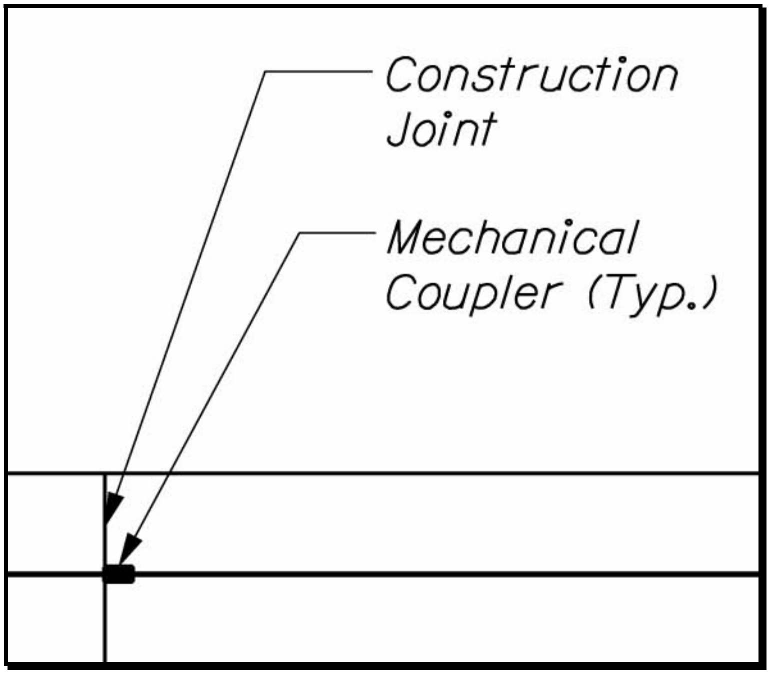


Figure 8-6 Mechanical Coupler

C. Welded Splices

In cases where neither a lap splice nor a mechanical coupler can fit, it is acceptable to specify a welded connection between bars. Generally this occurs with especially large bars, where the lap splice length is long and mechanical couplers are exceptionally large.

8.2.3.6 Projection

Projection occurs at concrete joints. Bars that extend through a joint have some length sticking out before the final placement of concrete. This length is called the projection length.

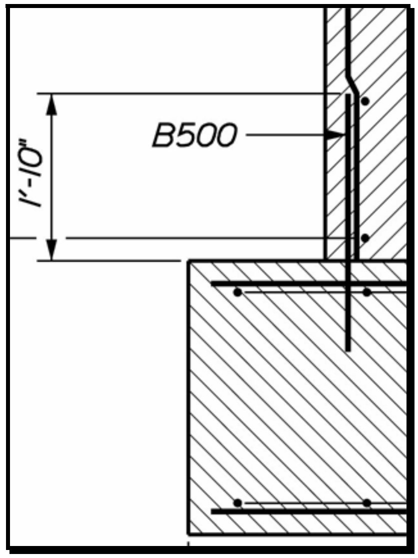


Figure 8-7 Dowel Projection

8.2.3.7 Joints

↳ Refer to *Bridge Design Guide* Section 5.2.4 for more detailed information on concrete joints.

A. Contraction

Concrete cracks, particularly due to shrinkage during curing. Contraction joints are used to control the location of these cracks. Reinforcing steel is not generally carried through contraction joints, except in rigid frames and integral abutments.

B. Expansion

Expansion joints allow adjacent placements of concrete some freedom to expand and contract with changes in temperature without crushing or moving each other. Expansion joints may occur where these expansion forces change direction, for instance a wingwall turn. Reinforcing steel is not carried through an expansion joint.

C. Construction

Construction joints are used between concrete placements when the sequence of construction requires more than one placement. These joints may be designed to coincide with contraction or expansion joints. If not functioning as a contraction or expansion joint, reinforcing steel is normally carried through the joint.

8.2.3.8 Top Bars

Top bars are horizontal bars with more than 12" depth of concrete cast below the reinforcement. It is suggested that multiple horizontal bars in a single vertical plane such as column ties or horizontal bars in walls need not be considered top bars. Bars considered "top bars" require longer splice lengths. An example of top bars would be the top mat of reinforcing steel in a footing.

8.2.3.9 Some Common Bar Types

A. Dowels

Dowels are short straight bars usually joining two placements of concrete, for example between a footing and a wall. The length of the bar will be determined by embedment, splice and projection requirements.

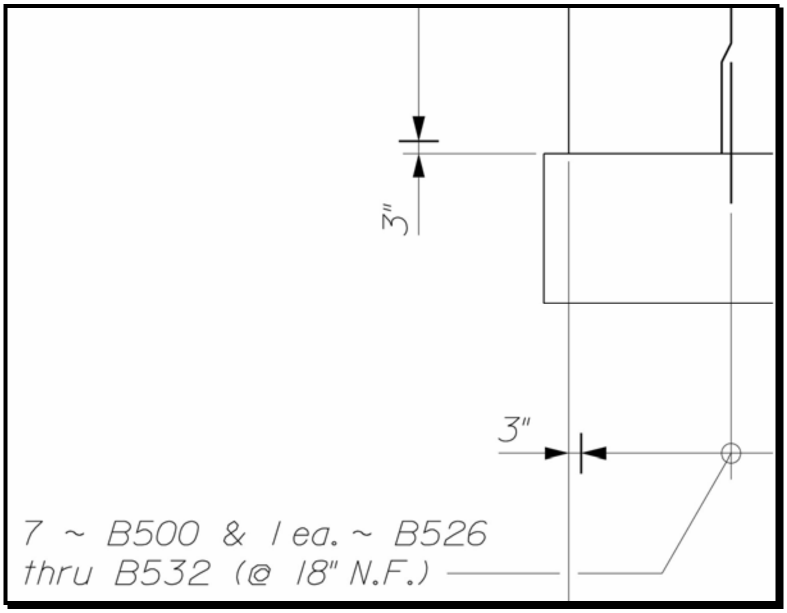


Figure 8-8 Dowel Callout

B. Stirrups

Stirrups are bent bars, usually found in curbs, precast voided slabs, and superstructure haunches. Stirrups usually form a U shape, with or without additional legs, and have at least three straight legs.

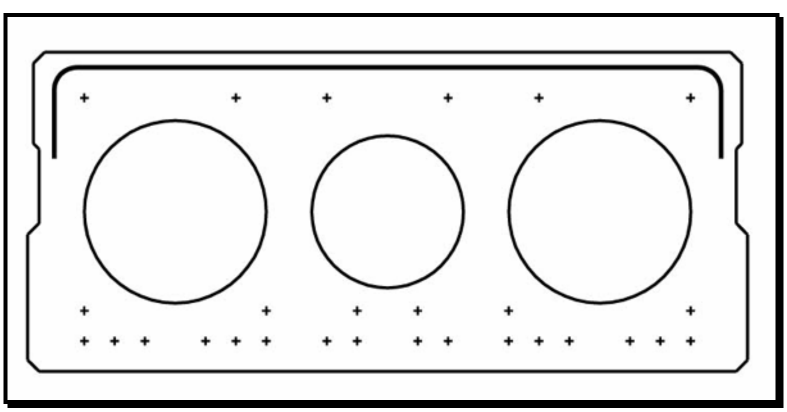


Figure 8-9 Simple Stirrup

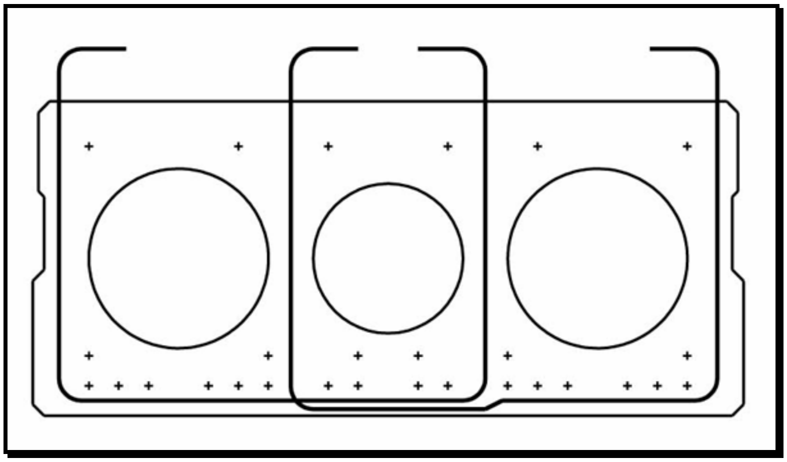


Figure 8-10 Stirrups With Legs

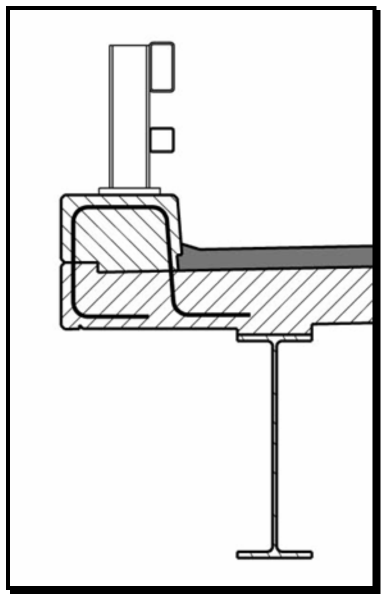


Figure 8-11 Curb Stirrup

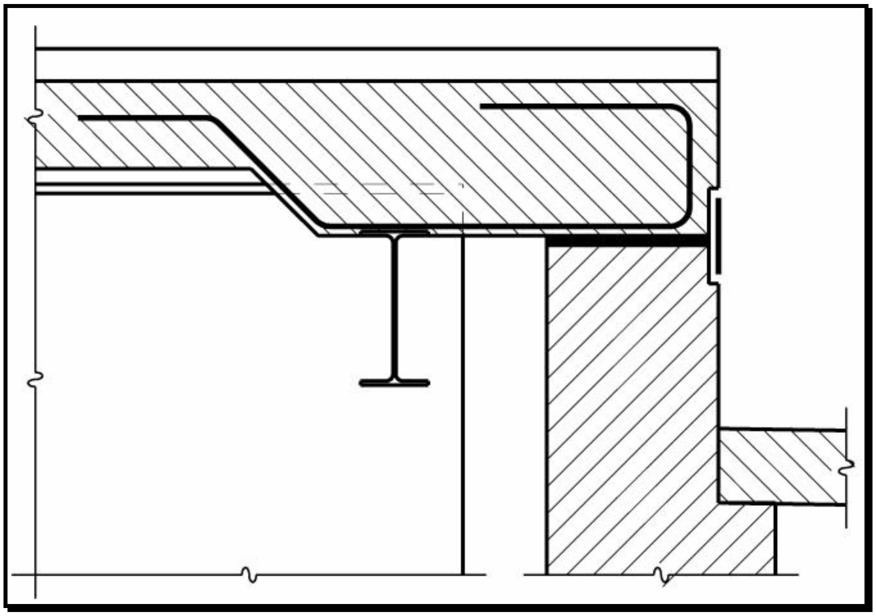


Figure 8-12 Superstructure Haunch Stirrup

C. Crank bar

Crank bars are usually transverse superstructure bars. The crank shape is the most efficient way to provide top steel and bottom steel where they are required (top steel over beams, bottom steel in spans between beams).

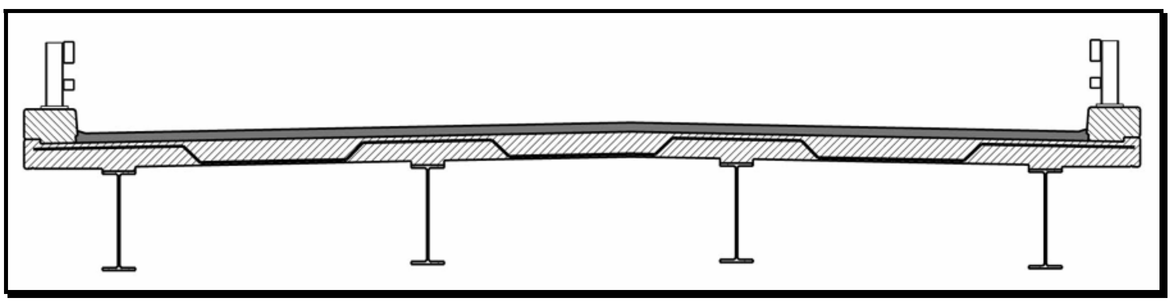


Figure 8-13 Crank bar

D. Hairpin

Hairpins are bent bars, typically found as transverse bars in superstructure fascia, concrete barriers and transition barriers. Hairpins have a 180-degree bend and at least two straight sections with or without additional legs.

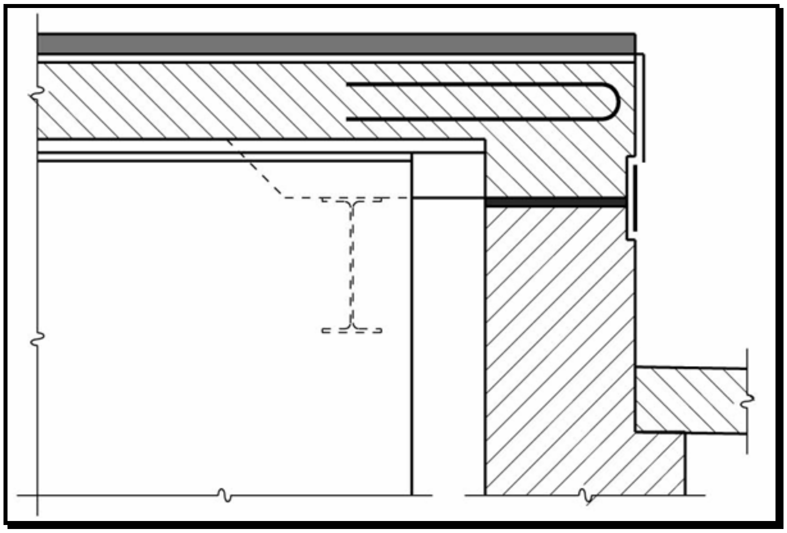


Figure 8-14 Simple Hairpin

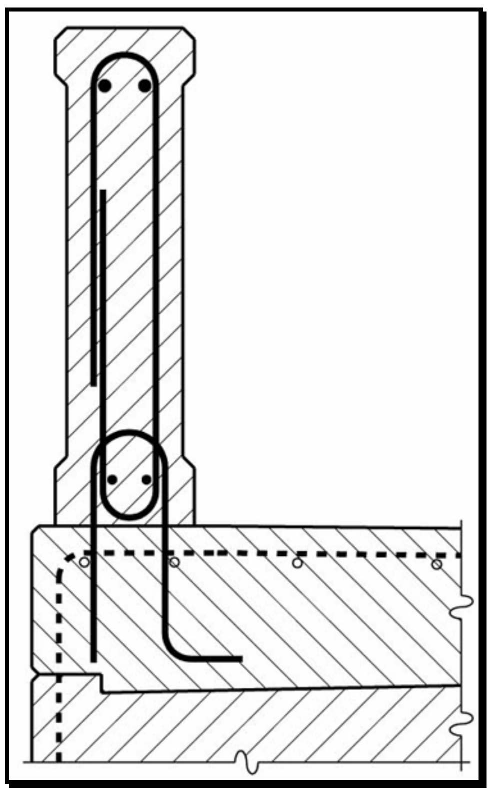


Figure 8-15 Rail Hairpins

8.2.4 Responsibilities of the Designer

The Engineer or Designer provides the following:

- Bar size and spacing
- Bar Cover requirements

- Projection
- Sketches that clarify design intent
- Splice lengths
- Embedment depths
- Location of Concrete joints
- Bend radii when required

The Detailer is encouraged to discuss all of these aspects of the reinforcing with the Designer before proceeding with work and as issues arise.

8.2.5 Detailer as Designer

8.2.5.1 Detailing as a Check for Design

Detailers are responsible for communicating the design to the Contractor. Detailers need to completely understand and visualize the geometry of the structure to accomplish this. Often, the Detailer comes to a more complete and detailed understanding of aspects of the structure than the Designer, and is able to offer the Designer insights that may help either improve the design of the structure or solve unexpected problems with the structure or constructability of the structure.

> ⓘ **Detailing is an important check for many aspects of Design. Keep on the lookout for interferences and always try to understand the reason for every line you put on the drawing.**

8.2.5.2 Design by Experienced Detailers

With experience, the Detailer begins sharing Design responsibility. A Detailer with knowledge of standard practices can accomplish many elements of design.

> ⓘ **An experienced Engineer should check all Design work, particularly Design performed by a non-Engineer.**

Detailers typically will not design main reinforcement – it is up to the Designer to determine the size and spacing of bars. However, there are certain properties of reinforcing steel that can be preliminarily set by the Detailer. These might include:

- Splice Lengths
- Embedment Lengths (enclosed vs. unenclosed hook embedment)
- Hook and Bend Geometry
- Projection
- Clearances
- Cover Requirements (chart of cover)

- Temperature Steel

8.2.6 List of References

8.2.6.1 Specifications

It is important to start by reading the MaineDOT Standard Specifications. Some important sections are:

- 502 Structural Concrete
- 503 Reinforcing Steel
- 518 Structural Concrete Repair
- 535 Precast, Prestressed Concrete Superstructure
- 709 Reinforcing Steel and Welded Steel Fabric

8.2.6.2 Bridge Design Guide

- Concrete Joints: 5.2.4
- Concrete Cover: 6.1.4.1, 5.4.1.5,
- Drill and anchoring: 6.2.3
- Splices
- Reinforcing Steel 6.2.1.2
- Concrete Slab on Steel Girders 6.2.2.1

8.2.7 Standard Drilled & Anchored Bolts and Reinforcing Steel Notes

(The following note is used for Type 1 anchors when bolts are size 7/8" or greater.)

1) For drilling and anchoring bolts size 7/8" or greater, the anchor material chosen from the Maine DOT prequalified list shall be submitted to the Resident for approval.

(The following note is used for Type 3 anchors when reinforcing bars are size #9 or greater.)

For drilling and anchoring reinforcing bars size #9 or greater, the anchor material chosen from the Maine DOT prequalified list shall be submitted to the Resident for approval.

8.2.7.1 CRSI Manual of Standard Practice

This manual is a wealth of information about reinforcing steel. For example, there is information on hook and stirrup bending criteria, as well as a chart for weight per foot of bars that can be used for estimating purposes.

It is highly recommended that a new detailer peruse this book prior to their first reinforcement detailing project.

8.2.7.2 Standard Details

Become familiar with the standard details that show rebar, such as end posts, approach slabs, and construction joints.

8.3 Step One: Gathering Information

It is critical to familiarize yourself with the structure before you begin to put lines on paper. Putting lines on paper is the easy part of the job: it's putting the lines in your head that really takes effort. That is what this step is about.

8.3.1 Geometry

First, the concrete section should be completely designed and that design should be checked: there's nothing worse than having to reinforce a section 3 or 4 times because the geometry of the element keeps changing.

♬ Make certain that the concrete has been drawn to scale. Compare the dimensions and elevations as labeled to the actual length and location of lines in your CAD file. Pay particular attention to wing lengths and elevations, bridge seat elevations, parapet elevations, concrete joint locations, and seal elevations.

Check to be sure that the following elements have been included, where applicable. They may affect the shape of the structure you are reinforcing.

- Expansion joint material between the parapets and the superstructure fascia.
- Bearing material under precast boxes on abutments and piers. Make sure bearings have been designed and checked to the correct height.
- Make sure concrete joints have been located.

8.3.2 Design

Next, you should get the reinforcing scheme from the designer. Information should include:

- Bar size and spacing, for example: #5 @ 12" E.F. Many structures require multiple bar sizes and spacings. Size and spacing may be different on near face vs. far face, top vs. bottom, wing vs. breastwall, horizontal vs. vertical, etc.

♬ Spend some time with the designer's sketches before you begin to lay out the rebar and make sure you understand the scheme.

- Bar Layout, for instance, does the design require stirrups at the top or ends of the structure? This information will typically be communicated with a design sketch of a section and/or plan and/or elevation.

8.3.3 Application of Reinforcing Concepts

Once you have the specific design criteria for the project at hand, you must apply some reinforcing standards that will help you detail bars. Track down these standards by talking to the designer, experienced detailers and by referring to reference guides.

8.3.3.1 Cover

What distance must be maintained from the face of the concrete to the reinforcing steel? This number might be different from a breastwall to a footing, from an abutment to a pier and from the top to bottom of a superstructure slab. Check with the designer to determine what cover was used in the computations.

- ♬ Some of this information may be found in the *BDG* but the detailer should always double check with the designer.

Refer to 8.2.3.2 for more information.

8.3.3.2 Splices

It's likely that you'll require at least one splice in any reinforcing scheme. The splice length varies depending on bar size, bar location and bar type. For example, epoxy-coated bars require a different splice length than black bars.

When two bars with different splicing requirements are spliced together, the shorter of the two splice lengths governs.

Check with the designer if there is any question about what splice length is required.

Refer to Section 8.2.3.5 for more information.

8.3.3.3 Embedment

It's also likely that you'll need to use embedded bars, for instance in a footing. You should find the embedment distance, projection length, whether the bars need to be hooks or straight, etc. Again, this is a design decision.

Refer to 8.2.3.3 for more information.

8.3.3.4 Hooks

You may also be dealing with some hooked bars. Standard hook dimensions are easily found in reference guides, discuss any exceptions and variations with the designer.

Refer to 8.2.3.4 for more information.

8.4 Step Two: Layout

There is no disguising the fact that laying out reinforcing steel is a time-consuming and complicated process. The best approach is to take your time and be as systematic as possible. You are well on your way if you have gathered the information as we discussed in Step One.

The goal of this step is to determine the location, number of bars, and length of bars required to reinforce the structural element. To achieve this you'll start with the structural details and apply clearances, splice lengths, embedments, and hook geometries that you gathered in step one.

By the end of this step, you'll be ready to complete a plan, elevation and sections necessary to fully document each bar's number and location. You'll also be entering the bars' designations into the reinforcing schedule, along with the number of bars and bar size, bend type, and location.

As you lay out the reinforcing steel, try to consider how you will annotate the bars.

- Keep it Clear: focus on making the layout as straightforward and constructible as possible. Remember, it's cheaper to have a few extra pounds of steel on the project than to have such a complex rebar layout that it causes the Contractor to make a mistake.

8.4.1 Draw Clearance Lines

In your plan, elevation and section views, draw lines that represent the cover requirements. These lines will usually be either 2 or 3 inches inside the outer limits of the concrete and parallel with the surface.

These are construction lines that will help you locate and determine the correct length of bars.

8.4.2 Draw the Bars

Using plan, elevation and section views, draw single lines and solid circles to represent each bar.

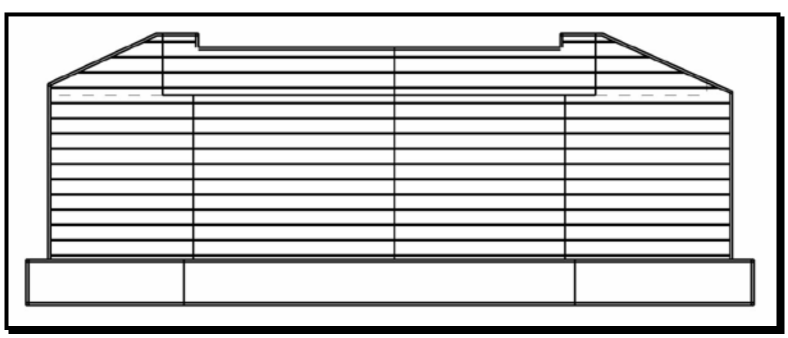


Figure 8-16 Working Sketch of Abutment Elevation

- Draw to scale – you may need to go back later and move lines around to make it read better, but right now you're detailing this to be measured and recorded, so draw to scale.

These are working sketches and the lines should either be construction elements or you should work with copies of your plans and elevations to avoid making unwanted changes to the documents.

Use multiple plans, elevations and sections as necessary to help you plan the reinforcing in the front and back, top and bottom and at various points along the structure.

♬ Note that these single-line representations aren't strictly accurate, as reinforcing bars obviously have a thickness to them. In some rare instances where clearances are tight (precast voided slabs and boxes, for instance) it may be necessary to draw up the bars completely and carefully showing the bar thicknesses. For the purpose of most reinforcing, however, it is safe to simply draw a single line.

8.4.3 Standard Practice

8.4.3.1 Design Clearance

Reinforcing can be a maximum of one-half the design spacing from any expansion or unreinforced joint or limit of concrete placement. For example, when placing an array of vertical bars in a wall with an expansion joint (no horizontal bars passing through), the bars must be no more than half the design spacing on either side of the joint.

8.4.3.2 Bar Lengths

Reinforcing steel is available in lengths up to 60 feet.

♬ When using long straight bars often times designers will use a minimum bar size of #5 because anything smaller is very flimsy and hard to handle in the field.

8.4.3.3 Substructure

A. Back Hooks

When reinforcing a wall section, always put a hook on the far face vertical bar that is enclosed in the footing to prevent the Contractor from placing the bar after the footing concrete has been poured.

B. Wing Steel

When laying out vertical steel in an abutment wing, start at the wing end and place the first vertical bar six inches in. Space the rest at the design spacing. This provides enough length to tie the vertical bars to the horizontal bars.

C. Interference

Piles and girders will occasionally interfere with the placement of reinforcing steel. Be sure to check for these interferences and figure your reinforcing steel accordingly. In some cases, girders and piles may be drilled to allow reinforcing steel to pass through. In other cases, bars may be spaced around the interference. Be sure to check with the Designer for a recommendation.

D. *Vertical Bar Spacing*

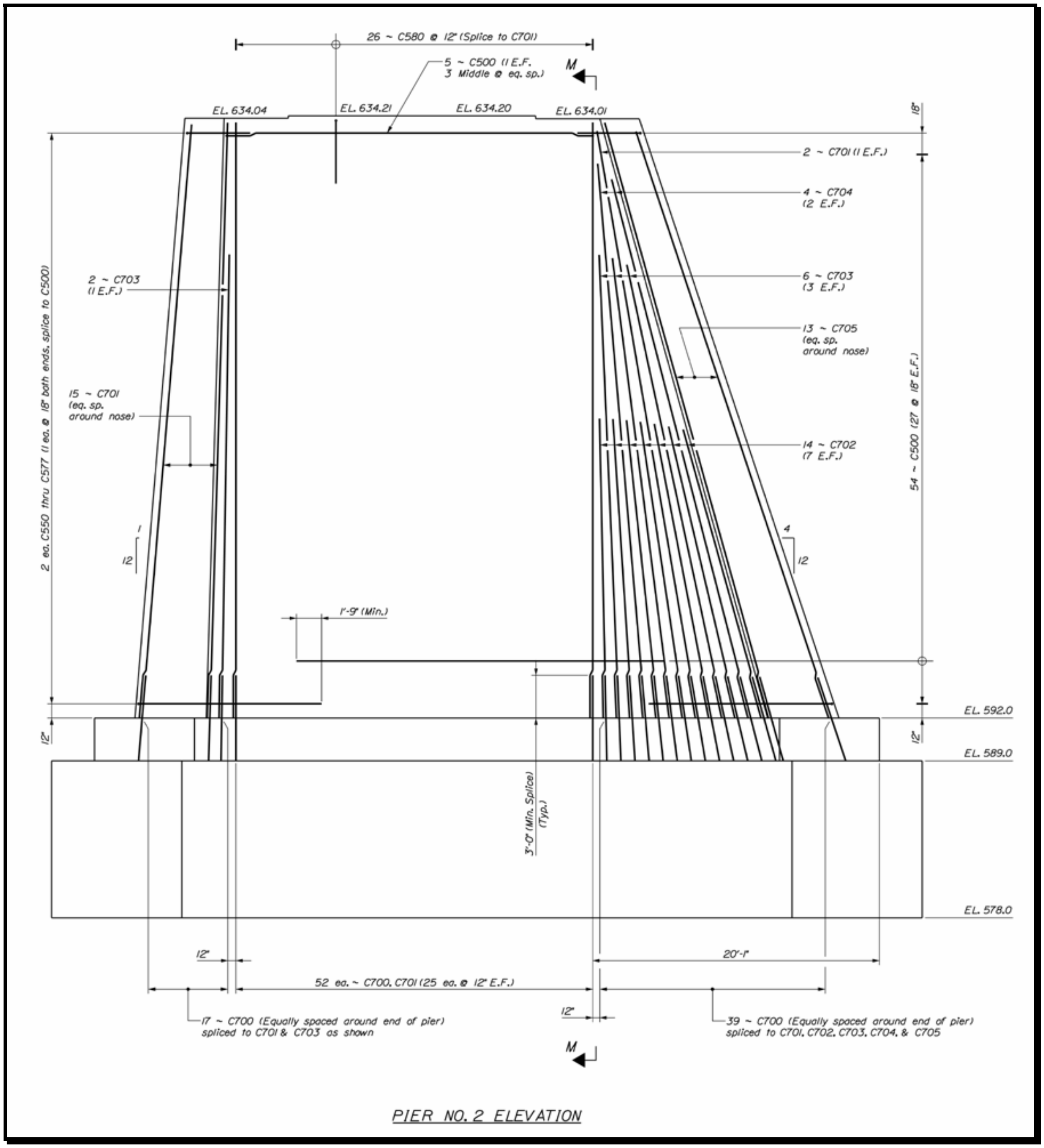


Figure 8-17 Pier Elevation

To call out the number of vertical bars in the nose of a pier, first lay out the bars exactly, using even bar spacing around the nose. Then call out the number of bars and designate the layout as "even spacing."

A large mass pier with battered faces has bars that get closer together. At the bottom of the shaft, vertical bars are spaced around the perimeter of the shaft at the design spacing. As those bars taper together, some can be left shorter. Look for the point at which the bars close to one-half bar spacing apart. At this point you can shorten every other bar while still maintaining the design spacing.

Work from the elevation view, in general the upstream end of the shaft where the nose is most sharply battered is going to be the most difficult area to work with.

8.4.3.4 Superstructure

A. Skew

Reinforcing steel in a superstructure should be parallel to the skew of the substructure up to a maximum skew of 25 degrees. Greater skews than this require reinforcing steel to be placed normal to the span. In either case, the spacing for the bars is measured along the centerline of the stringers.

B. Crank Bar

When precast concrete superstructure deck panels are not offered as an option to the contractor, the structural designer may use crank bars and straight bars as main reinforcement.

The BDG does not address crank bar layout. Use Figure 8-18 as a guide in crank bar detail development.

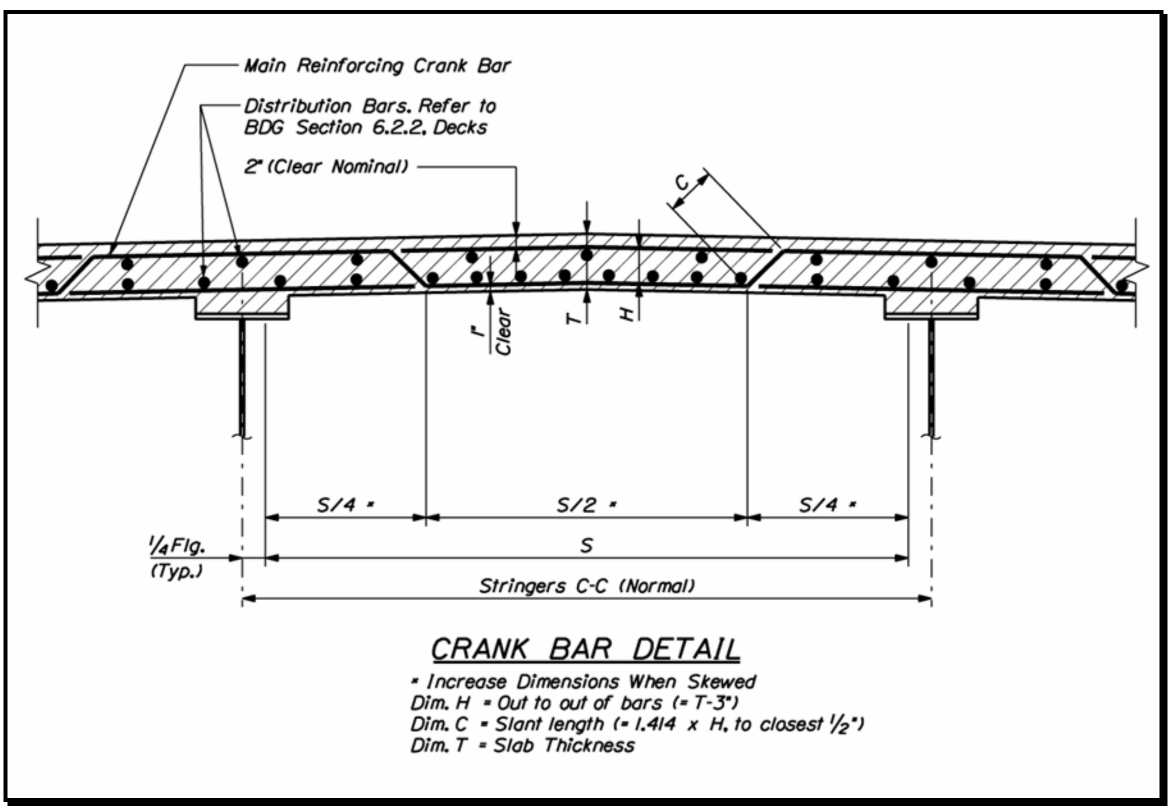


Figure 8-18 Crank Bar Detail

C. Splices

Longitudinal steel in structures more than 60 feet long will require splicing. Add a note to your superstructure plan that instructs the Contractor to stagger the splice locations.

D. Add'l Reinforcing

Curbs with curb-mounted rail systems require additional reinforcing under each rail post.

It is acceptable to call out these bar counts and designations with a note, shown under the "Plan" label, with a heading of "Additional Reinforcing Not Shown."

- ♬ Refer to Standard Detail Section 507 Curb Reinforcing Plan & Sidewalk Reinforcing Plan.

Extra longitudinal reinforcement may be added in the slab and curb in negative moment areas such as over piers.

E. Bridge Drains

It is unnecessary to lay out reinforcing steel to fit around bridge drains. There is a general note that covers adjusting steel around drains.

8.4.3.5 Precast Box Beams and Voided Slabs

Precast boxes and voided slabs require a great deal of precision when laying out reinforcing steel. Close work with the Designer is required, and the Detailer will often find it necessary to draw the bars completely to scale to insure a proper fit.

8.4.3.6 Welded Wire Fabric, Wire Mesh

Wire meshes and fabrics are mats of smooth steel used primarily in thin slabs. In bridge work they are typically found in precast deck panels.

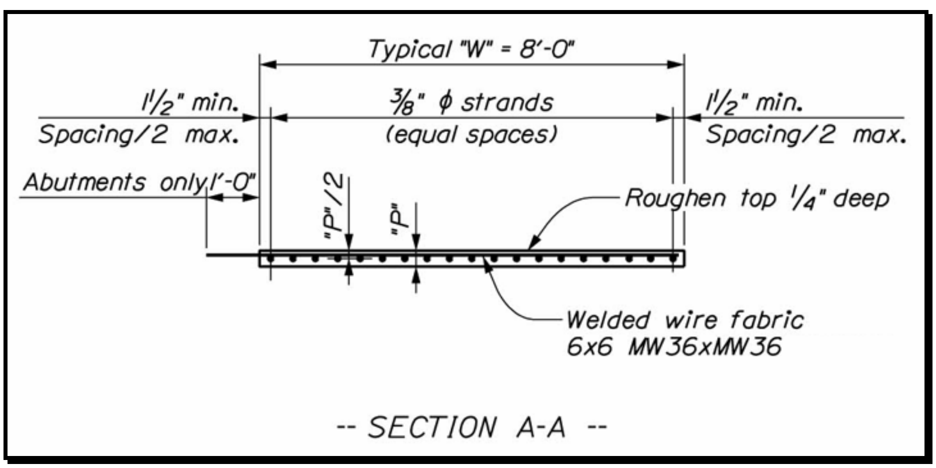


Figure 8-19 Welded Wire Fabric

8.4.3.7 Approach Slabs

Don't forget to include approach slab bars in your reinforcing steel schedule. Check the Standard Details for layout requirements.

8.4.4 Tactical Detailing

There are a few tricks of the trade that will help the detailer in situations where the design spacing of reinforcing doesn't fit for one reason or another.

Steel is designed by area – this means that the main reinforcing is designed such that a percentage of the cross-sectional area of the concrete is taken up by steel. Because of this, it typically doesn't matter if you have to shift bars one way or the other by a couple of inches.

Tying up reinforcing in the field is not an exact science. They'll make it work out in the field if you give them enough bars and a reasonable idea of where they'll fit.

8.4.4.1 Reduce Spacing

Rebar spacing given by the designer is a maximum spacing and can be closer if the structural geometry requires it.

In some cases, you'll find you can't place an array of bars in the structure, while meeting both cover requirements and using the design bar spacing. For short arrays, it is acceptable to space the bars equally, rather than using the design bar spacing.

It is also acceptable in some cases where the spacing is irregular to simply show each bar and label them "space as shown."

8.4.4.2 Flare

Another acceptable layout technique is to flare bars. Bars are often flared to provide reinforcing around a corner of a footing. It is important to maintain the minimum spacing as required by the design when laying out flared bars.

This is a common practice in abutment footings, as shown in Figure 8-20.

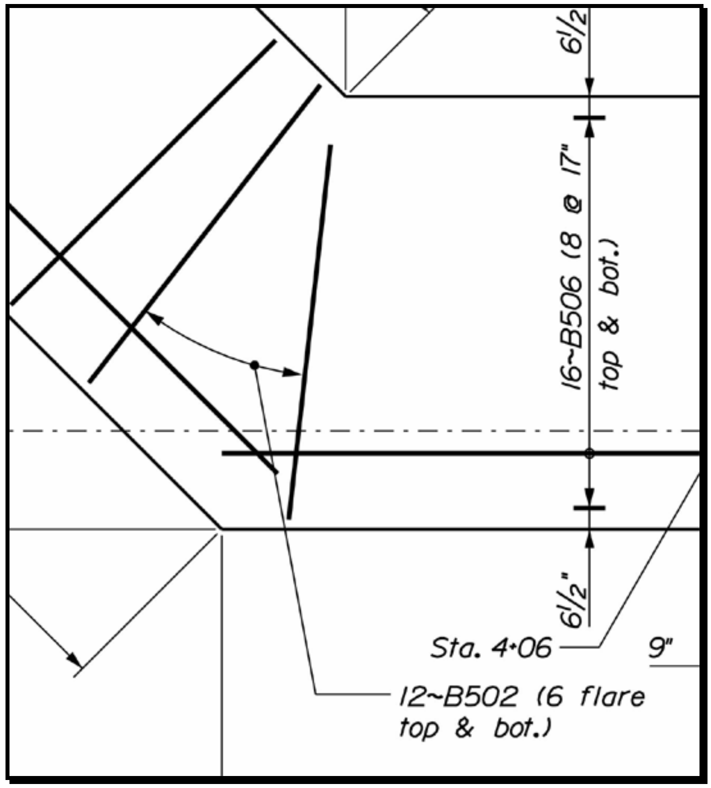


Figure 8-20 Flare Bars in Footing

8.4.4.3 Cut to Fit

In some rare instances it is useful to instruct the Contractor to cut reinforcing steel in the field to fit some particular geometry. An example of this is cutting the bars in a concrete collar around a pipe arch.

> ⓘ **This is a last-ditch effort type of solution. Do not make a habit of it and always ask an experienced Detailer for a second opinion on how to avoid specifying a "Cut to Fit."**

8.4.4.4 Bend in Field

Reinforcing steel bars of number 5 or smaller can be bent on the job site. There are rare occurrences where a bend cannot be specified on the rebar schedule, for instance, a bar that requires two bends that are non-planar.

> ⓘ **Epoxy-coated bars cannot be bent in the field.**

8.5 Step Three: Make a Draft Schedule

This step involves establishing a bar mark for every bar, then counting and measuring each bar and recording your results in a draft schedule.

At this stage you will also consider a couple of ways of reducing the number of different bar designations required.

8.5.1 Setting the Bar Mark

8.5.1.1 Overview

Bar Marks (i.e. A500, P550, S405) are made up of three parts: the letter, the size and the serial number.

The letter shows whether the bar is a superstructure bar ("S") or an Abutment No. 1 bar ("A") or a Pier bar ("P") etc.

Table 8-1 Bar Mark Letter Usage

Bar Letter	**Location**
A	Abutment Number 1
B	Abutment Number 2
P	Pier
S	Superstructure
PC	Precast
AS	Approach Slab

The next number is the bar diameter, i.e. a number 5 bar.

The second two numbers are a kind of "serial number" for the bar – each different bar needs a unique name, these last two numbers provide that.

♬ Bars numbered XX00 through XX49 are typically straight bars. Bars numbers XX50 through XX99 are typically bent bars.

8.5.1.2 Numbering Bars

There are some general rules of thumb to follow as you assign numbers to the bars in your structure.

- Bars numbered 00 through 49 are typically straight bars.
- Bars numbered 50 through 99 are typically bent bars.

- Reserve numbers 00 through 05 for dowels.
- Reserve numbers 50 through 55 for hooks.
- As much as possible, number bars by concrete placement, i.e. keep footing bars together, breastwall bars together, etc.
- Number bars in the order they will be used: footing bars should have lower numbers than the bars in the structure that rests on the footing.
- Consecutively numbered bars should be somewhere near each other in the structure, i.e. don't skip around from wing to breastwall.
- Label vertical bars first, because they have to go in first.
- Number bars left to right.
- Number bars bottom to top.
- Number near face before far face.

> ⓘ **Leave some spaces for numbers in between sets so you can add bars later.**
>
> ⓘ **If you have more than 100 bars, you can break it up so that Footing bars are designate as "F" bars.**

A. Abutment Bar Numbering Tips

Number the breastwall steel first, then the wings. With symmetrical wings, this will allow you to use the same numbering for both wings.

B. Superstructure Bar Numbering Tips

Start numbering from the longest bars. These are the longitudinal steel.

8.5.2 Scheduling Straight Bars

Fill in your temporary schedule. Start by organizing all the bar marks.

Next, count the number of each bar, and note the location. Refer to further documentation for specific terms to use in calling out bar location.

Next, measure the bars and note the length. All the bars that you have drawn in your working drawing should be drawn to scale, with the correct cover, the correct splice lengths, embedments, etc. Use the computer to measure the lengths of the bars.

8.5.3 Scheduling Bent Bars

Fill in your temporary schedule with all the bent bar marks.

Count the number of each bar and note the location.

Determine the bent type for each bar by referring to the reinforcing steel schedule.

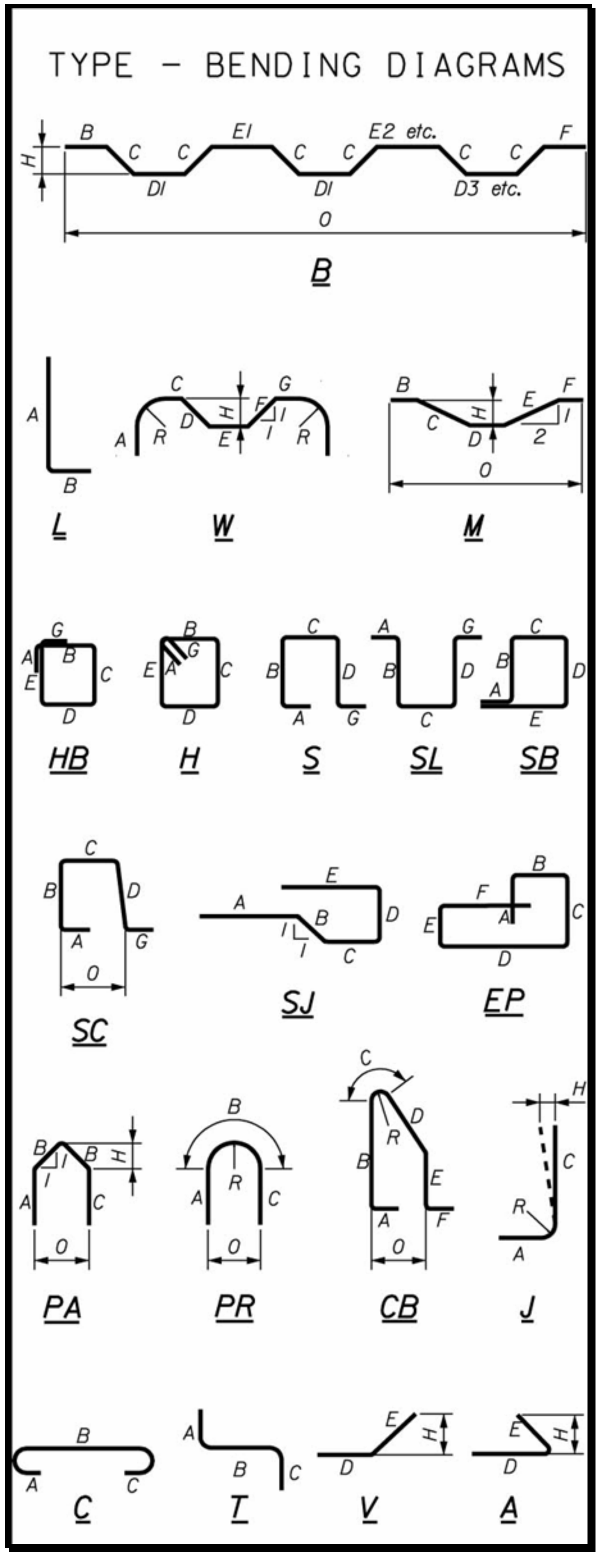
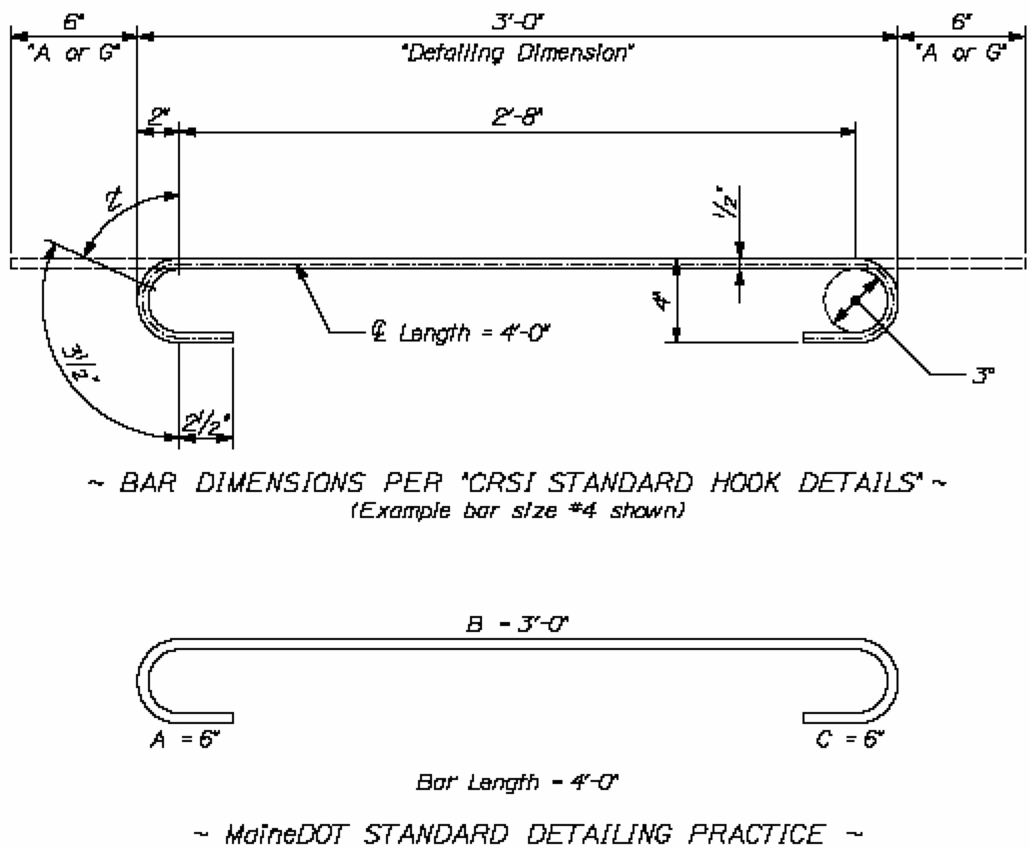


Figure 8-21 Bent Types

Note that each bent bar has more than one length to measure: often you have to measure not only the length of each leg, but also the overall height, width, and occasionally a radius. Each of these items is labeled with a letter, A-H, O or R. These designations are also shown on the reinforcing schedule.

- The Type C bar has radiuses at each end and this can create some confusion about how the dimensions are calculated for the Reinforcing Steel Schedule. The following illustrations show how the Type C bar lengths should be figured.



TYPICAL HOOK DIMENSIONING

- What if there is no bent type that matches your bar? First, ask a second opinion: there may be a way of cleverly using an existing bar type to show your bar – think of using a bar type with more legs than you need and setting some leg lengths to zero. If you do need a new bent type, simply give it a name and draw it on the rebar sheet. Label the legs, always starting with leg A, and ending with leg G. Use "R" for any radius, "H" for a height and "O" for an overall dimension.

Measure each leg, plus any overall dimensions that are required for the bent type and note them in your temporary schedule.

- Remember that in most cases, bent bars are dimensioned "out to out."

8.5.4 Rounding Lengths

Once you have measured and noted the bar lengths exactly, you're going to have to round them to a reasonable length.

What is a reasonable length? In general, we want to round to an even number of inches.

> ⓘ **Sometimes greater accuracy is required, i.e. a precast voided slab stirrup. Talk to the Designer if you have questions about rounding.**

Some bar lengths are going to need to be rounded up, some down. How can we tell which?

- In general, round the length of a bar or leg **down** only when both ends of the bar or leg are controlled by cover requirements.
- Round the length of a bar or leg **up** in all other situations.

Some examples:

- Round **up** if the bar is spliced onto another bar
- Round **down** if a bar is a stirrup that spans the width of the structure.
- Round **down** if a bar runs the entire length of the structure
- Round **up** if one end of the bar ends in the middle of the structure, far away from any joint.

8.6 Step Four: Annotation

Once you have assigned bar marks to every bar and have completed your draft reinforcing schedule, it's time to label, dimension, and schedule the bars.

There are basically four pieces of information that need to be provided for each bar.

1) Number of Bars. This "Count" should only be shown in one place on the drawings. Do not label the number of bars more than once.
2) Bar Designation, e.g. "A500." The letter is used to differentiate bars in different parts of the structure, "A" for abutment number 1, "B" for abutment number 2, "S" for superstructure, etc.
3) Spacing. You must specify the spacing of the bars, whether it is 18", 12", 6", etc. Make sure you only label the spacing once.
4) Location. Sometimes you must specify "EF" for "Each Face" or "NF" or "FF" for "Near Face" or "Far Face." This information is not required if the location of the bars is clarified in a section view.

♬ These abbreviations need to be defined on the plans in a legend.

8.6.1 Show the Bars

8.6.1.1 What to Show Where

Abutment bars should be shown in the elevations and sections. The count should be shown in the elevation. Sometimes it's easier to have two drawings of abutment, one for geometry one for reinforcing.

Pier bars should be shown in the elevation and section, count should be shown in the elevation.

Superstructure bars should be shown in the plan and transverse section. The count should be given on the plan.

8.6.1.2 Simplify the Scheme

Sometimes you can simplify your drawings with a simple change to the reinforcing scheme.

If two adjacent bars are almost the same length, consider eliminating one designation and leave one just a little short or a little long. Be sure to look at your cover, splice, and embedment requirements when deciding on a final length.

If a series of bars are to be spliced, consider using a single bar and varying the splice lengths. This is called "over-splicing." Again, be sure that minimum splice length is maintained.

♬ In general, don't call for over-splicing of more than half the bar's length.

8.6.1.3 Don't Show Every Bar

If you have 3 or more of any single bar, you should always show a single bar along with a dimension that shows the range of bar placement.

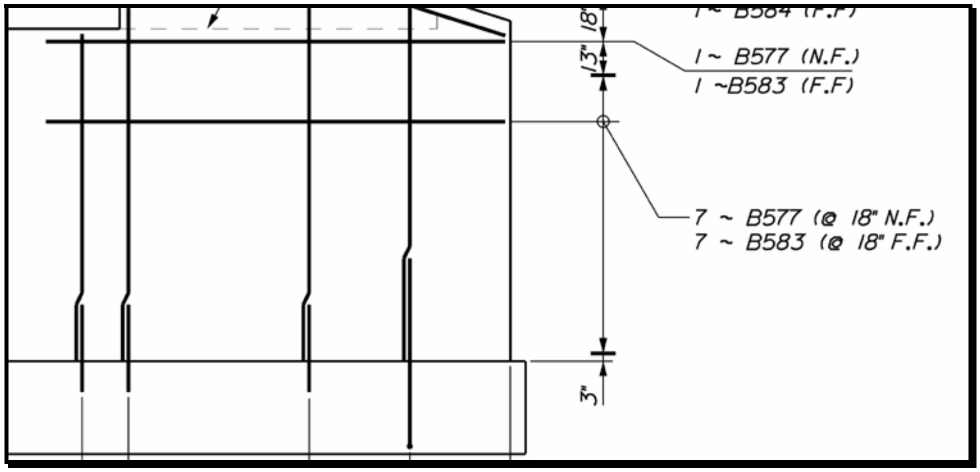


Figure 8-22 NF & FF at Multiple Locations

8.6.1.4 Pointing to Single/Double Bars

The simplest method of annotation is to simply point at the one or two bars being labeled.

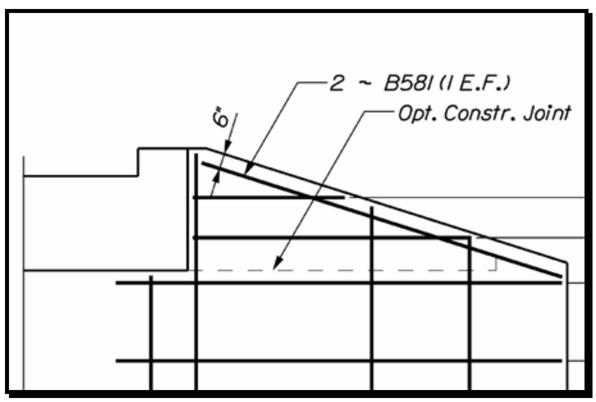


Figure 8-23 NF & FF at 1 Location

8.6.1.5 Showing Multiple Bars

Multiple placements of a single bar designation can be shown in a couple of ways.

A. Showing an Array of Multiple Bars

Sometimes the design calls for a range of bars that grow sequentially longer or shorter. This is similar to showing multiple placements of a single bar.

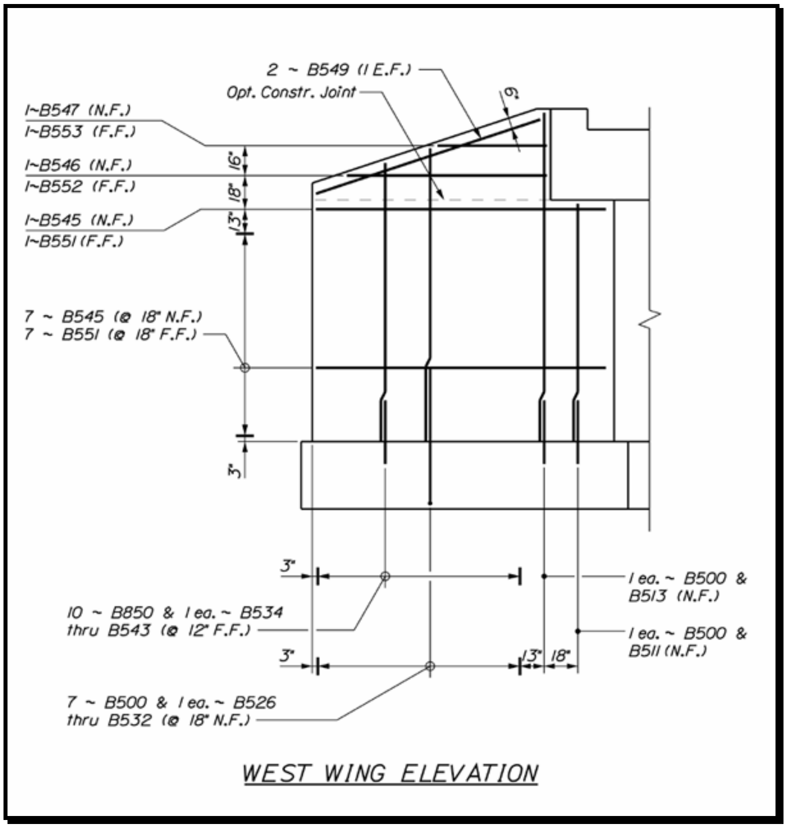


Figure 8-24 Spliced Arrays

B. *Multiple Sets of Bars*

Often you will be faced with annotating a series of bars that are tied together. An example would be in the breastwall of an abutment, you might have a hook tied to a vertical bar tied to a stirrup. These could be called out with a single array.

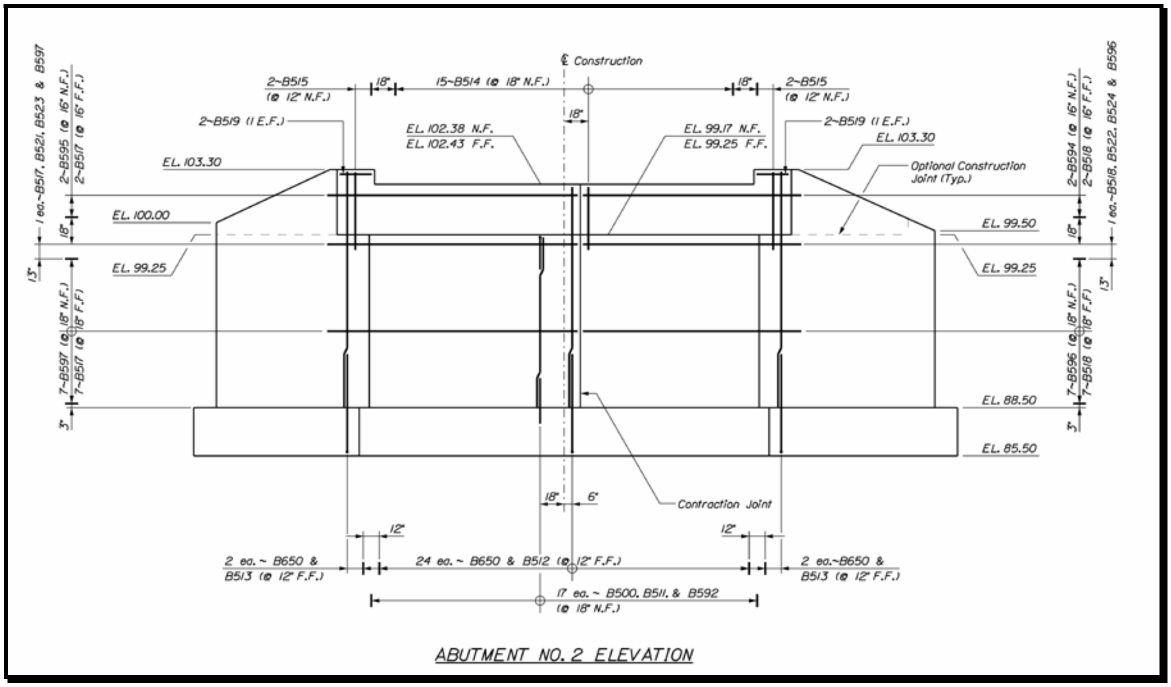


Figure 8-25 Spliced Sets at Multiple Locations

8.6.2 Label the Bars

Each bar needs to be labeled with a designation, spacing, location and count.

↳ Refer to Dimensioning section, below, for location annotation requirements.

In order to save room and provide a readable plan, you have to simplify your details as much as possible.

8.6.2.1 Standard Grammar

There are a number of acceptable ways to label. Here are some examples.

- 52~A500@18" N.F.
- 52 ea.~A500&A525 (26 of each @ 18" E.F.)
- 10~A500 (5@18" E.F.) spliced to 2 ea.~A511 thru A515 (1 of each E.F.)
- 8~A525 (4@18" E.F.)
- 2 ea.~A510 thru A515 (1 of each @12" top & bott)
- 4~A503 (2 flare top & bott.)

For Spacing, there are three acceptable ways to label.

- At a spacing – 10~A500 @ 18" N.F.
- Equal Spacing – 10~A500 @ Eq. Spacing N.F.
- Space as Shown – 10~A500, Space as Shown N.F.

8.6.2.2 Calling out Bar Locations

Call out bars per side, using either upstream/downstream or North/South/East/West or even Left/Right side (remembering that Abutment 1 "Left" bars will actually be shown on the right side of the abutment elevation.)

8.6.3 Dimension the Bars

All bars must be dimensioned off some reference; either centerline construction, reference line, construction joint, or an edge of concrete.

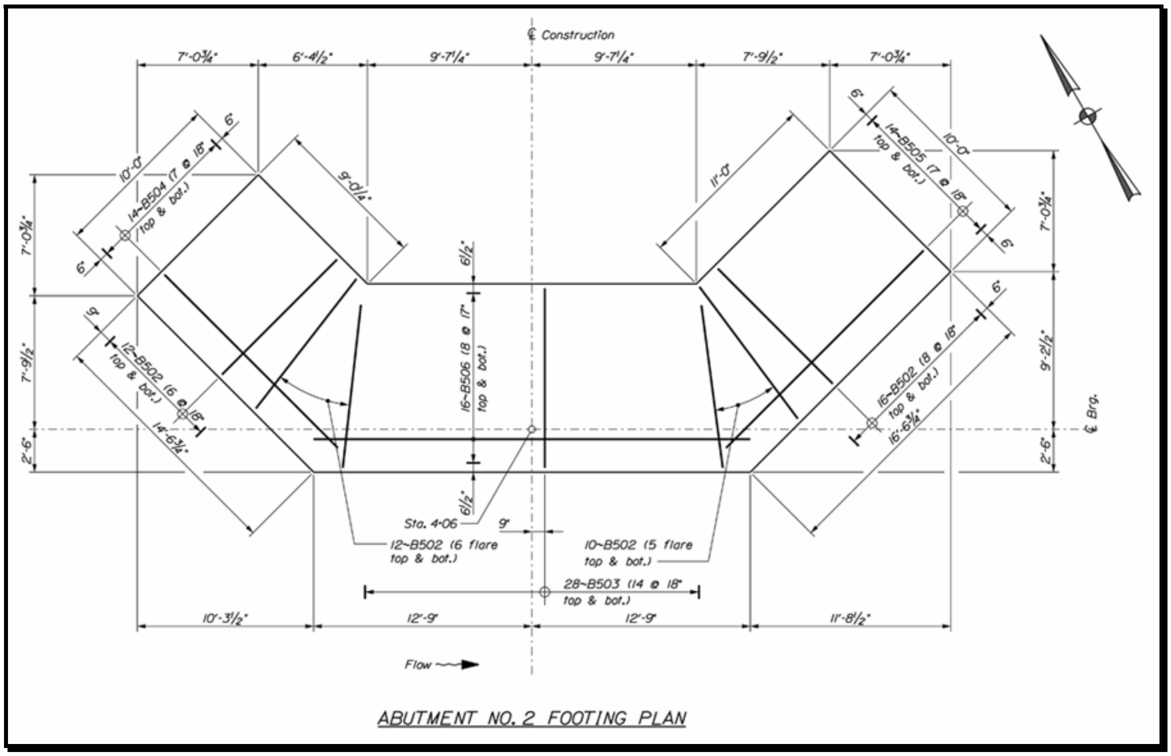


Figure 8-26

ⓘ **Reinforcing steel clearances are not a substitute for this reference.**

If an array of bars is spaced at a given distance, you only need to tie one end of that array to an acceptable reference. However, if bars are spaced either at equal spacing or "as shown" each end of the array needs to be tied to an acceptable reference.

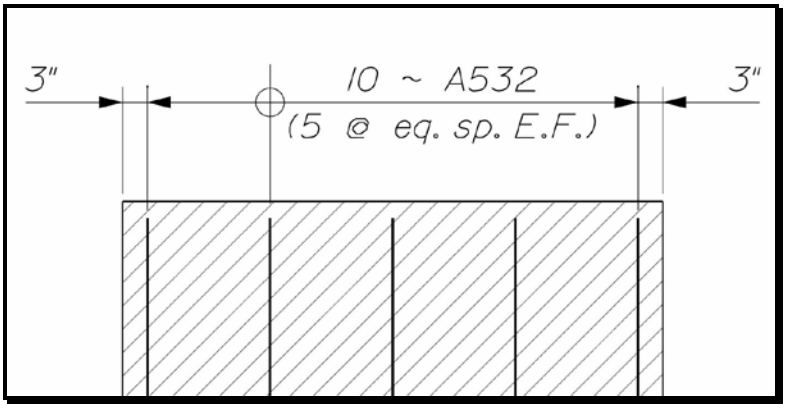


Figure 8-27

8.6.4 Schedule the Bars

The final step of annotation is to fill in the reinforcing steel schedule. With a completed draft schedule, simply copy your bars into the final schedule.

Some things to be sure to check when scheduling:

- Make sure every bent type called for is detailed on the sheet. If it is not shown in the Bending Diagrams, you can remove some unused bar types off the sheet to make room to draw your own bar type diagram for that specific bar.

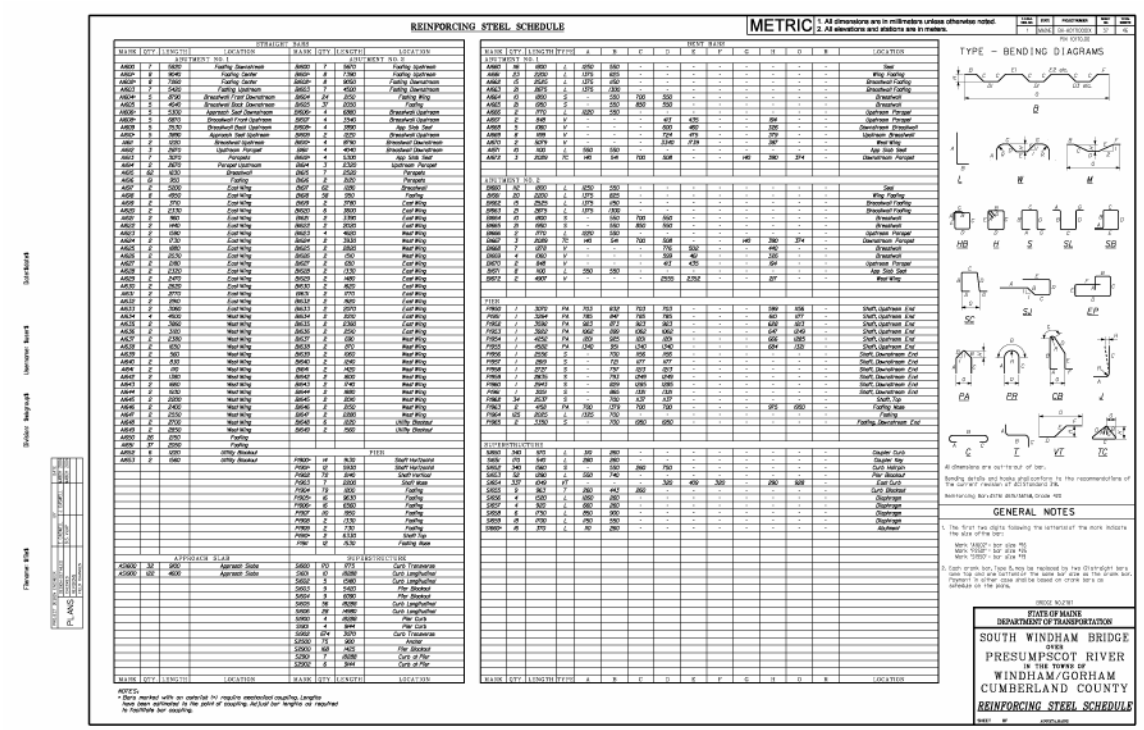


Figure 8-28 Reinforcing Steel Schedule

8.6.5 Typical Sheet Contents

Will Contain:

1) Schedule of Straight Bars
2) Schedule of Bent Bars
3) Type-Bending Diagram
4) General Notes

8.7 Step Five: Checking

Look in *Bridge Design Guide* to read about checking policy.

Verify quantity and length of main reinforcing.

Things to look for:

1) Check from paper instead of from the computer.
2) Look at rebar schedule and count bars
3) Make sure that any bars shown as typical or detailed in one place meant to apply to more than one location
4) Make sure you include your approach slab bars

CHAPTER 9 DETAILING PRACTICES

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9.2 Fundamentals

9.2.1 Sheet Layout

This section is reserved for a future discussion of the following:

1) Nesting details on a sheet/white space around details
2) Typical locations of plans, details, notes
3) Line up ortho views of same scale

9.2.2 Detail Layout

This section is reserved for a future discussion of the following:

1) White space around object
2) Offset of dimension lines and text
3) Housekeeping: parallel leader lines, aligned text

9.2.3 Text

9.2.3.1 Rules for Capitalization

A. Standard Sentence Capitalization

Standard capitalization applies to notes and annotations. Capitalize first letters of sentences and proper nouns.

B. All Caps

The information that is typically found in the middle of a title sheet (i.e. bridge name, waterway, town name etc...) and the conjunctions (i.e. "OVER" and "IN THE TOWN OF") are all capitalized.

Detail titles shall be all capitalized and underlined. <u>ABUTMENT NO. 1</u>

Item descriptions and units on the Estimated Quantities Sheet may be in all capital letters.

- ♬ It is preferable to have the items formatted with Title Formatting (upper and lower, each major word capitalized) but the MEDOT estimating software used to track items defaults to all uppercase letters and it is permissible to leave it that way.

C. Title Capitalization (Major Words Uppercase)

The first letter of each word in the name of a specific item description in a note shall be capitalized.

Example: Erosion control mix may be substituted in those areas normally receiving loam and seed as directed by the Resident. Payment will be made under item 619.1401 Erosion Control Mix.

The first letters of the name of MEDOT specific documents shall be capitalized.

Example: Placement shall be in accordance with Standard Specification 619 Mulch.

D. Capitalization Exceptions

The following words should be capitalized as proper nouns when referring to a specific person on the project:

1) Contractor
2) Engineer
3) Resident
4) Bidders
5) Project Manager

The first letter in the word Contract shall be capitalized when referring this specific one.

Example: Payment shall be incidental to Contract items.

↳ For guidance and examples of capitalization not covered here, refer to Standard Notes.

9.2.3.2 Abbreviations

The following words are commonly abbreviated. Follow these standard abbreviations, using the capitalization as shown.

Word to be abbreviated	Abbreviation
Typical	Typ.
Minimum	min.
Abutment	Abut.
Bearing	Brg.
Number	No.
Elevation	EL.
Wearing Surface	W.S.
Near Face	N.F.

Far Face	F.F.
Each Face	E.F.
Bottom	Bot.
Equally Spaced	eq. sp.

The following words may be abbreviated in certain uncommon circumstances. Use the following standard abbreviations, and capitalize as shown.

Concrete	conc.
Structural	struc.
Wearing Surface	W.S.

ⓘ **Do not abbreviate the words Construction or Contraction, as their abbreviations may be confused during construction.**

9.2.4 Dimensioning

9.2.4.1 Referencing

Dimensions should be referenced from the Centerline of Bearing, Centerline of Construction, or a reference line based upon these two lines.

If you are dimensioning to an existing structure, locate a point that has been surveyed well and that you are confident can be established in the field, such as a bridge seat or backwall. Check the location of the point by verifying it in reference to other lines and using the existing plans.

9.2.4.2 How and Where to Dimension

When dimensioning a concrete structure that will be formed, such as an abutment or a pier, the corners should be tied down from two directions. Generally this is done along and perpendicular to the structure, not along the skew.

Dimensions and labels should be kept outside of the object lines. This keeps the object in tact, the detail less cluttered, and clearer to understand.

Dimensions should not be repeated on the same or other details. Avoid dual dimensioning. An object with a given elevation should not be vertically dimensioned.

9.2.4.3 Stacking Dimensions

The line of dimensions closest to the object should be spaced ¾ inch away from the nearest object line. Sometimes they need to be further out, such as when you have annotation that you want to avoid crossing the dimension lines lines. The subsequent dimension lines should be stacked ½ inch apart.

9.2.4.4 Organizing Dimensions

The lines of dimensions should relate to each other if possible. Referenced points on a plan that are at the same elevation could be on the same line of dimensions. An example of this would be to dimension the base of a solid pier plan all on one line, and the top on another line. Another way would be to organize the dimension lines by placements of concrete. This could help to avoid the mistake of referencing to something that hasn't been cast yet.

The dimensions should be organized so that the crossing of extension and dimension lines is kept to a minimum. This can be done by keeping the dimensions on the outside extents of the object furthest away from the object, and then work your way in. An example would be to keep the line of dimensions of the base of the solid pier further out than line for the top of it. If crossing lines become confusing to the eye, sometimes you can clear it up by deleting part of an extension line which a dimension line passes through. It is better to avoid deleting part of a dimension line or part of an object line. This practice of deleting parts of lines should be reserved for extenuating circumstances, and not used as a general rule of thumb.

Dimensions should not be repeated anywhere on the plans in any form, because this opens the door to errors if changes are made during the development of the plans and all of the repeats are not edited. When a vertical measurement is expressed with elevations the information should not be repeated with a dimension.

When dimensioning an object with two or more strings of dimensions, one should not close more than one dimension string because it opens the door to cumulative errors if all strings of dimensions do not total up to the same number.

9.2.4.5 Laying Out Curved Surfaces

Occasionally one is called upon to lay out a curved surface such as the curb on the superstructure plan of a curved bridge. This can be accomplished with offset dimensions to a straight reference line similar to the way a camber diagram is drawn. On curved surfaces at this scale, usually offsets at ten foot increments is sufficient.

9.2.4.6 Dimension Tolerances

Concrete should be dimensioned to the nearest one-quarter inch.

Structural steel should be dimensioned to the nearest one-sixteenth inch.

Camber Dimensions Should be given to one eighth inch

Blocking Elevations Should be within 0.02 feet.

Bridge seat elevations should be given to the nearest 0.01 feet

All other structural elevations should be given to the nearest 0.10 feet

9.3 Putting Out Multiple Projects in One Plan Set

This section is reserved for a future discussion.

9.4 Combining Bridge and Highway Drawings in One Package

This section is reserved for a future discussion of the following:

9.4.1 Duplication of Effort

9.4.2 Estimating Delineation

9.5 Checking

9.5.1 Introduction

Sitting down to check a set of plans can be an overwhelming task because there are many different facets to consider. It is best to establish an organized approach so that one doesn't overlook anything, or spend too much time on less important items. Every set of plans should be checked. It doesn't have to take long, but it is a one of the most valuable blocks of time spent on a set of plans.

Please reference section 1-7 of the Bridge Design Guide for further information.

9.5.2 Priority

One needs to understand where it is most beneficial to focus their attention, to get the most value from a check. One way to do this is to ask yourself, "What is the risk to the cost and quality of the final product?" The effort should be directly proportional to the amount of effort spent checking that part of the plans.

Below is a list of things to consider in an order of priority to help you make decisions about where to focus the effort of checking. Numbers one thru four should be checked on every set of plans. Numbers five and six are important but are occasionally sacrificed or quickly reviewed due to schedule constraints. This list is not necessarily in the chronological order that they will be checked. Keep in mind that the focus of this list is toward a detailing check, and not a design check. Design correctness and safety should be addressed during the design check. It is assumed that while the project is being detailed, the plans are being periodically reviewed by the designer to assure that the basic concept and significant components are consistent with the design.

1. Is it constructible?
    a. Is it physically possible to construct it as shown?
    b. Is all the necessary information there so that it can be built?
    c. Are there any dimensions referencing things that don't yet exist?
    d. Does the order of construction make sense?
2. Is the information (major dimensions, elevations, labeling etc.) correct?
3. Has the method of payment been established?
    a. Is there a pay item or is it incidental to something else?
    b. Has payment been mistakenly indicated by more than one method?
4. Is the information complete and understandable to a person who is familiar with reading plans?
5. Do the details meet established industry and Bridge Program standards?
6. Are the spelling, grammar and capitalization correct?

ⓘ **Before beginning to check a set of plans one should be familiar with the special provisions and the history of the project and its issues.**

9.5.3 Checking Lists

Here are some lists of things to check and some common errors for use when checking plans. These are in no particular order.

9.5.3.1 General

1. Are all the necessary sheets included in the set of plans?
2. Are all the necessary details included?
3. Is all the necessary information on the details?
4. Is it detailed according to standards?
5. Are the dimensions and elevations within tolerance for the detail type?
6. Check Spelling
7. Check Capitalization
8. Check grammar
9. Is the hatching in the correct places and is it the correct style?
10. Has the signature block been filled out?
11. Has the correct border been used?
12. Are detailing methods consistent from sheet to sheet.

9.5.3.2 Checking a Title Sheet

1. Do the specifications refer to the current versions of AASHTO and the Standard Specifications.?
2. Are all the appropriate materials listed?
3. Are all the appropriate specs listed?
4. Check the Hydrologic Data and Traffic Data against the numbers in the PDR.
5. Does the Utility List include only the companies relative to this project?
6. Are the page numbers correct and are all of them included?
7. Check the spelling
8. Is the project located on the location map?
9. Is the signature block filled in with the names of the PM, Designer, Consultant etc.
10. Is the project number and bridge number correct?

9.5.3.3 Checking Notes

1. Does the note serve its intended purpose.
2. Does the note conflict with other details or specifications?
3. Do the notes refer to a specific item number or specification number, and has that number changed during the design process.
4. If the note directs some work to be done, does it also describe how it will be paid for, and to what specification the work is to be constructed?
5. Are all the editable variables filled in?
6. Is the note clear to anyone who reads it?
7. Are all the necessary notes there?
8. Are there some copied in notes that need to be removed?
9. Does the note follow good technical writing standards?

10. Do the references to the MaineDOT field representative say "Resident" as it should, or do they say "Construction Manager" or "Engineer"?
11. Is the spelling and capitalization correct?

9.5.3.4 Preliminary Plan

1. If the bridge has a superstructure, are the alignment curves off the bridge if possible, and is there at least a 1% grade across it for drainage?
2. Do the wing lengths and the fill around them look reasonable?
3. Are all the temporary and permanent impacts shown?
4. Are the property lines and clearing limits shown?
5. Are the contours shown?
6. Be sure to check the spelling because this will be seen at a public meeting.

9.5.3.5 General Plan

1. Has more than one alignment been developed, and if so is the correct one shown?
2. Is the horizontal curve data correct?
3. Have all the required details and levels been shown? (See Chapter 2)
4. Check the low points of the approaches for potential runoff and erosion problems.
5. Do the wing lengths agree with the structural plans?
6. Do the guardrail limits agree with the current structure, or have the structure/wings or transition barrier changed since the Preliminary plan was developed thereby changing the guardrail limits?
7. Does the project length fall on even stations if possible?
8. Does the plan agree with the cross sections?

9.5.3.6 Profile

1. Are the vertical curves geometrically correct? Are the leg lengths equal?
2. Do the PVC and PVT fall on even stations if possible?
3. Is all the required information shown? (see Chapter 2)
4. Do the profile elevations agree with the cross section elevations?
5. Do the stations at centerline of bearing (if shown) agree with all the others shown on other sheets?

9.5.3.7 Cross Sections

1. Do the elevations at centerline of bearing agree with the profile?
2. Do the cross sections agree with the plan?
3. Is all the required information show?
4. Check the superelevation.
5. Check the cross slopes of the travelway and shoulders.
6. Check the subgrade drainage.
7. Check the ditch elevations and flow.

8. Do the guardrail limits agree with the current structure, or have the structure/wings or transition barrier changed since the Preliminary plan was developed thereby changing the guardrail limits? Do they agree with the general plan?

9.5.3.8 Structural Details

A. Cast in place Concrete Substructure

1. Check the geometric design of the structure to assure that such things as the wing lengths & elevations, and the bridge seat elevations are correctly designed.
2. Check the major dimensions and elevations for correctness.
3. Are all the necessary details shown?
4. Are all the necessary dimensions and information shown so that it is constructible?
5. Do any of the dimensions reference something that wouldn't be constructed yet?
6. Is the station at the centerline of bearing correct?
7. Is the north arrow and flow arrow pointing in the correct direction?
8. Are the dimensions and reinforcing steel detailed using established standards?
9. Are the concrete joints shown and labeled correctly?
10. Are rebar splices needed at the construction joint locations?
11. Check the rebar splice lengths and embedment lengths.

B. Metal Plate Structures

1. Check the invert elevations
2. Check the barrel length
3. Check the Plate thickness
4. Check the end cut height
5. Check the weight
6. If it is an aluminum structure, does it have a top step or end reinforcement?
7.

C. Structures with Precast Slabs or Beams

1. Do the abutments need horizontal construction joints at the parapets and do they have them?

D. Cast in Place Superstructures

E. Structural Steel

1. Spot check some bottom of slab elevations
2. Check some dimensions on the Framing Plan
3. Check to see if beam splice bolts interfere with shear stud placement.
4. Are weld symbols drawn correctly?
5. Are the dimensions on plates and bar annotations in the correct order?
6. Are all necessary details shown?

7. Is all necessary information shown on the details?

8. Are reference points and lines clear?

9. Do the bearing heights coo berate with the bridge seat heights?

10. If two beams with different dimensions are being spliced, do the filler plates add up correctly?

11. Check bolted connections for tool clearances.

F. Wearing Surface Rehabilitation

1. Is the thickness of the existing wearing surface different from the proposed, and if so do the drains and bridge joints need to be modified?

2. Do the approaches need to be transitioned up the new grade?

9.5.4 Reinforcing Steel Schedule

It is a good idea to talk to the designer or detailer to find out what changes or adjustments (if any) have been made to the geometrics of the structure during the design process, as this will give you a good idea of where to focus some of your checking. Some common adjustments are wings lengths and elevations, parapets, bridge seat elevations and footing elevations (especially if there is a seal).

1. Check to be sure that all the bars that are on the plans are also on the schedule.
2. Spot check the numbers of bars by counting them on some of the details.
3. If there are structures or parts that are exactly the same (such as two identical wings), with the same bar designations, make sure that the total number of bars on the schedule reflects it.
4. Spot check the lengths of some of the bars. Be sure there is adequate length for splices, embedment, and variable/adjustable lengths and that the bar can stay within the concrete cover requirements. Checking the main reinforcing is the higher priority.
5. If there is an approach slab, check to see if the bars are in the schedule.
6. If there is a separate precast concrete reinforcing steel schedule within the plans, be sure to check it.

9.5.5 Estimate Check

The estimate checker creates a simplified estimate that is done independently from the estimator. The focus of the effort should be on the big ticket items that represent the bulk of the cost of the project. Earth items don't need to be calculated exactly. They should be simplified so that one can obtain a reasonable ball park number.

1. Does the estimate include all the necessary items?
2. Do the items numbers correlate with other notes or references on the plans and special provisions?
3. Do the estimate sheets correlate with the estimate summary?
4. Does the Estimate Summary correlate with the Estimated Quantities Sheet?

9.5.6 Check Repeated Information

Repetition of information on the plans should always be kept to a minimum due to the potential for inconsistencies, but there are some situations where repeated information is accepted practice.

In some instances, such as pay items, information simply needs to be cross referenced.

This list is intended to cross check this information which you may find repeated or cross referenced in the Plans and Special Provisions.

- Check the centerline elevations on the profile against the centerline elevations on the cross sections.
- If one has repeated the stations of the centerline bearings, or the centerline of the pipe on the Plan, Profile, structural drawings or anything else, then they must be cross checked.
- Begin Transition, Begin Project etc. may be repeated on the Plan, Profile and Cross sections. These need to be cross checked.
- Check the Title Sheet Index to see that all sheets have been indexed. Check to see if the numbers on the upper and lower right hand corners are correct and that the sheet names on the title sheet agree with the names on the individual sheets.
- If specific pavement information has been given on the Typical Approach Section be sure that it is the same pavement, and the same thicknesses as is specified in the Pavement Specification.
- Check through all the notes on the plans to be sure that any pay item referenced is actually in the Estimated Quantities.
- Check all special provisions for pay items and be sure that they are included in your item lists.
- Check that all the items on the Estimated Quantities Sheet are also in the Engineers Estimate. Then check to make sure that the summary sheet reflects all the Items that you have sheets for and that the quantities match each other.

9.5.7 References for Detailing Standards

- Bridge Plan Development Guide
- Bridge Design Guide (Chapter 1, Section 1-7)
- AASHTO/NSBA Steel Bridge Collaboration Standards
- CRSI Manual of Standard Practice

9.6 Welding

9.6.1 Introduction/Overview

Welding is used in steel bridge construction in a variety of ways. It is used to fasten shear studs to beam flanges, pile tips to piles and bridge mounted rail posts to base plates. Built-up members ranging from bridge drains to plate girders can be created by welding individual plates and shapes together. Driving deep pile foundation wouldn't be possible without splicing shorter sections of pile together with field welds.

The types of welds most frequently encountered in bridge construction are the fillet and groove welds.

In the design documents, weld type, size, length, location and special instructions are conveyed to the fabricator through weld symbols. Using symbols allows a wealth of information to be condensed into a small space on the drawings. Understanding weld symbols is easier with a little background on the types of welded joints and welds.

9.6.2 Types of Joints

The type of joint is determined by the configuration of the elements being connected. Five common joint types are the lap, butt, tee, corner and edge joints as shown in Figure 9-1.

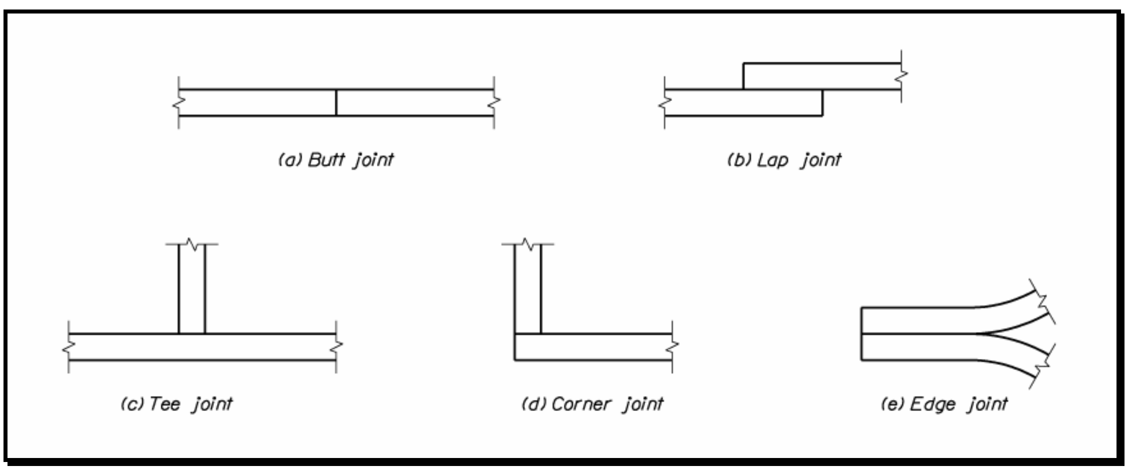

Figure 9-1 Common Types of Welded Joints

9.6.3 Fillet Welds

Fillet welds are typically used on lap and tee joints. For example, welding cover plates to girder flanges and welded girder flange to web.

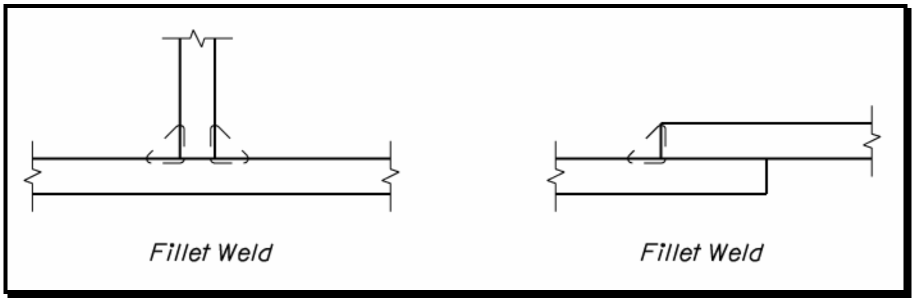

Figure 9-2 Fillet Welds

9.6.4 Groove Welds

9.6.4.1 Overview

Groove welds are always used on butt joints where the connecting elements align in the same plane, i.e. splicing sections of H-pile together.

Groove welds require more precise fit up than fillet welds. Groove welds have specified minimum and maximum gaps or "root openings" between the plates to be connected for weld rod access. Thicker plates require larger root openings. Root openings can be reduced and weld rod access improved by beveling or shaping one or both of the plate edges. Groove welds are classified by the shape of the groove cut in the plate edge. Several common types of groove welds are shown in Figure 9-3.

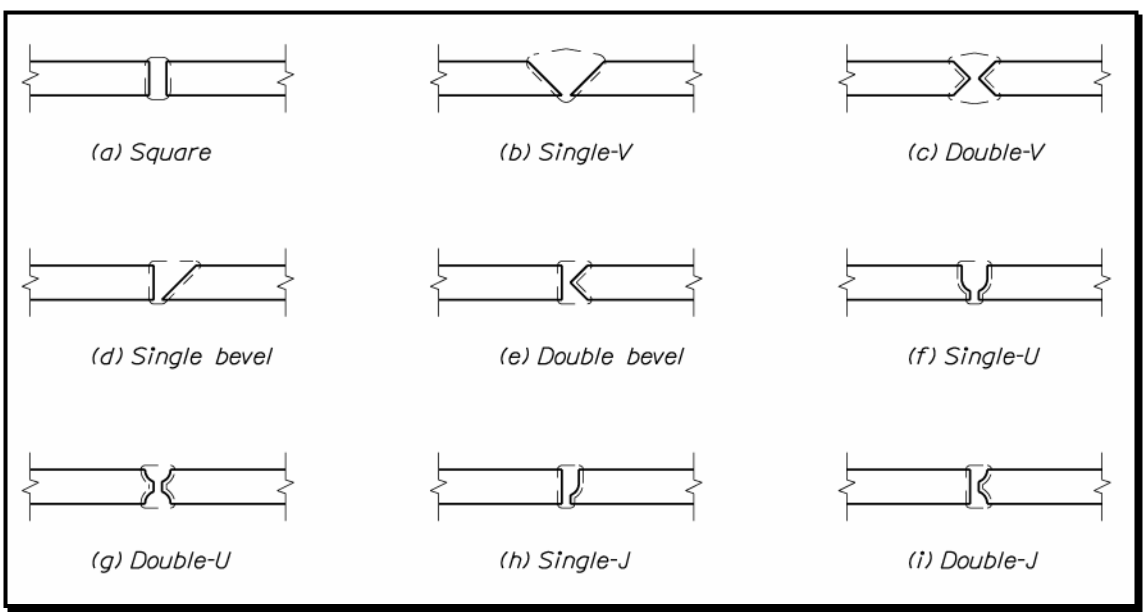

Figure 9-3 Types of Groove Welds

Groove welds may also be used in tee, corner and edge joints.

9.6.4.2 Complete versus Partial Penetration Groove Welds

When the depth of a groove weld extends through the entire thickness of the element it is called a complete joint penetration (CJP) groove weld. CJP groove welds are as strong as the elements being joined. When welds are required to develop the full strength of the member, such as when splicing lengths of H-pile together, CJP groove welds shall be specified.

When full member strength is not required, it is more economical to specify a partial joint penetration (PJP) groove weld. Partial penetration welds are used in the assembly of non-structural built-up components such as bridge drains.

9.6.5 Welding Symbols

The AASHTO LRFD and Standard Specifications state that welding symbols shall conform with the American Welding Society Publication A2.4, *Symbols for Welding, Brazing and Nondestructive Examination.* Refer to this document or the American Institute of Steel Construction's *Manual of Steel Construction, Allowable Stress Design, 9th Edition,* page 4-155 for a listing and description of the standard weld symbols. These documents also describe the standard location of elements of a welding symbol.

Typically a detailer will use the welding symbol macro within MicroStation to place weld symbols on the drawings. The macro dialog box is shown in Figure 9-4.

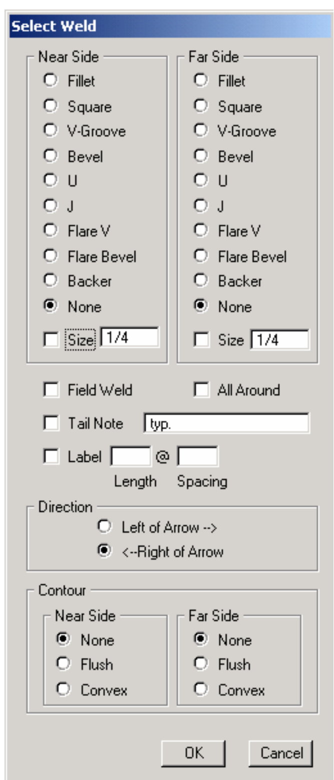

Figure 9-4 MicroStation Weld Symbol Macro

The detailer requires the following information to create the weld symbol:

- Type of weld
- Weld on near side, far side or both
- Weld size, if required (For more information on weld size, see Detailing Practices)
- Shop weld or field weld
- Weld all around or specific length
- Special instructions to be included in tail note
- For staggered welds, the length and centerline to centerline staggered spacing
- Contour requirements such as ground flush or convex

9.6.6 Detail Practices

The following welding symbols detailing practices:

9.6.6.1 Fillet welds

Do not include a fillet weld size on the weld symbol unless the size is greater than the minimum specified in AASHTO LRFD and Standard Specifications. The minimum size of fillet welds is based on the base metal thickness of the thicker part joined.

9.6.6.2 Complete Joint Penetration Groove Welds

Use the following weld symbol without dimensions to designate a complete joint penetration weld:

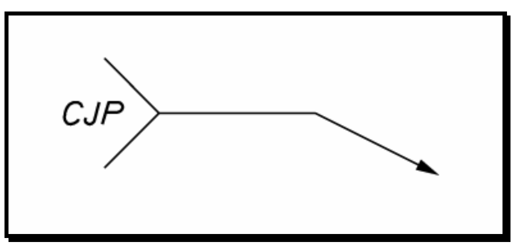

Figure 9-5 Complete Joint Penetration Callout

This allows each fabrication shop to choose the CJP groove weld that best suits their shop practices resulting in more economical steel fabrication bids.

9.6.6.3 Partial Joint Penetration Groove Welds

Use the following weld symbol with dimensions above or below the arrow to designate a partial joint penetration weld:

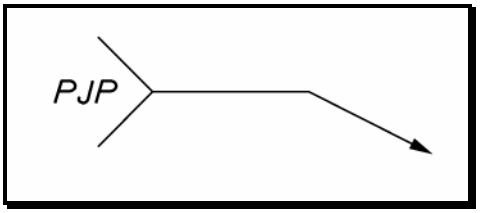

Figure 9-6 Partial Joint Penetration Callout

This allows each fabrication shop to choose the PJP groove weld that best suits their shop practices resulting in more economical steel fabrication bids.

9.6.6.4 Shop Welds and Field Welds

Clearly distinguish between shop and field welds.

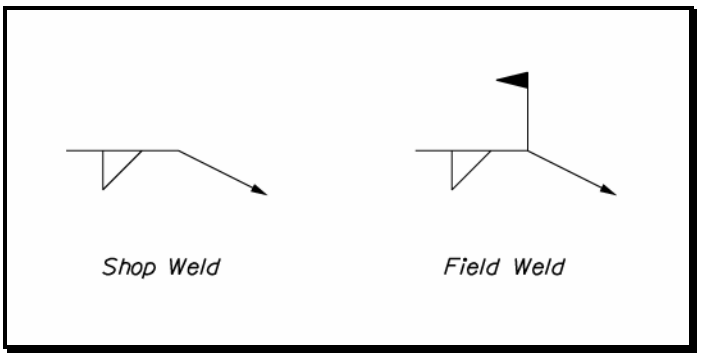

Figure 9-7 Shop Weld vs. Field Weld

9.6.7 Example of Weld Symbols on Drawings

9.6.7.1 Welded Plate Girder

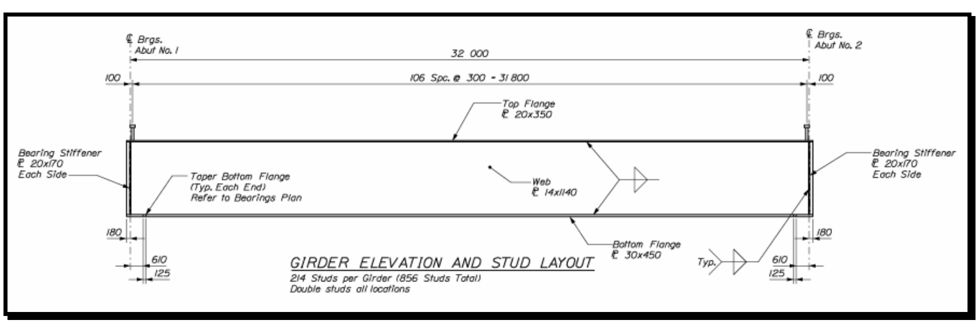

Figure 9-8 Welded Plate Girder Weld Example

9.6.7.2 Bridge Drain Standard Detail

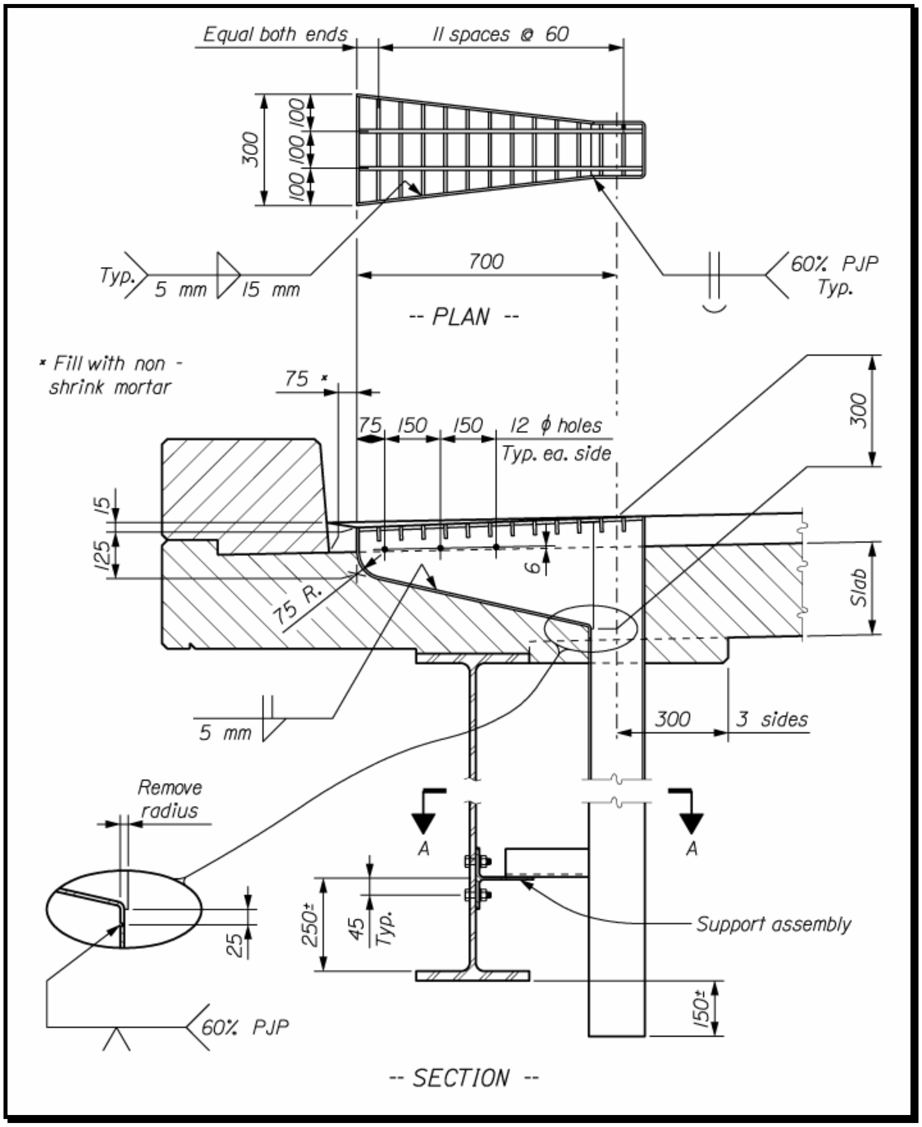

Figure 9-9 Bridge Drain Weld Example

9.6.7.3 Rail End Treatment

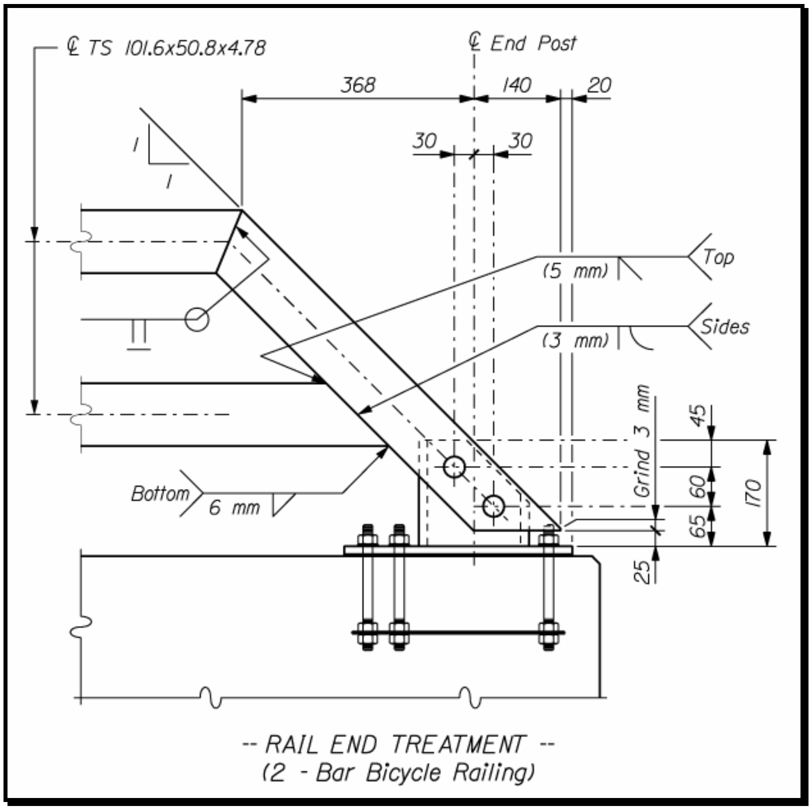

Figure 9-10 Rail End Treatment Weld Example

CHAPTER 10 ESTIMATING

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10.2 Computation of Quantities

201 - CLEARING (AC)

Clearing limits shall be parallel to and 5 feet (15 feet for FAI fills without guardrail and FAI low cut slopes) from the toe of slope or to the Right of Way line if it is inside the above limits.

Quantities less than 0.5 acre are incidental to contract items.

Quantities between 0.5 and 1.0 acre are rounded to 1.0 acre

202 - Removal Of Concrete Bridge Rail (LF)

Concrete railing shall be estimated as linear feet to be removed, out to out of the section(s) to be removed, and shall not be included in the deck or superstructure concrete removal item.

203 - Earthwork Quantities

General Methods

Use the most expedient method to measure areas (CADD cross-sections, etc.). Volumes are to be calculated by average end area method. Consideration should be given to unbalanced sections on sharp curves by using the length between sections at the centers of gravity.

- Increase all borrow volumes 15 percent for shrinkage.

Units:

Don't use Truck Measure

Common Excavation

Common excavation used to offset common borrow requirements should be credited at no more than 85 percent of its original volume.

Common Borrow

Increase Common Borrow volume 15 percent for shrinkage.

Granular Borrow

Increase Granular Borrow volume 15 percent for shrinkage.

Aggregate Subbase Course Gravel

Overhaul

Overhaul shall not be used on any projects.

202 - Removing Existing Bridge (LS/CY)

This item is under consideration currently. The depth of detail required to estimate the volume and/or weight of the structure is being debated. Ask before estimating.

206 - Structural Excavation Quantities

Pay Limits

Excavation for concrete structures shall be to vertical planes 18" outside the neat lines of the footing, or the bottom of the battered sections if there is no footing.

For abutments, box culverts and structural plate structures the limits shall be to the dimensions shown on the plans for granular borrow or French Drains if those limits are more than 18" outside the structure.

When excavation for a structure is specified to be carried beyond the customary 18" neat line, the additional excavation must be designated as "Structural Excavation" and modified structural excavation limits should be clearly identified on the plans.

For pipe culverts and drains the limits are 15" outside the pipe.

Excavation for footings placed as a seal shall be the same area as that used for payment for the footings.

Structural Rock Excavation should be estimated 6" below the minimum elevation indicated on the plans if excavation is definitely anticipated.

Methods

When calculating structural earth quantities adjacent to abutments with battered back faces the prismoidal formula may be required.

Extremely small quantities of excavation should be avoided by estimating 5 or 10 cubic yards to procure a reasonable bid price. Items for rock excavation may be eliminated when the quantity is very small, since there are provisions to pay for such rock excavation at six times the earth excavation price.

403 - Hot Mix Asphalt (T)

Hot Mix Asphalt shall be paid for by the Ton of each grading specified calculated at 110#/SY/inch of pavement thickness.

501 - Steel H Beam Piles (LF)

The estimated quantities shall be as indicated on the plans with no allowance for cut offs, splices or pile points.

502 - Structural Concrete (LS/CY)

Quantities for structures that are not supported on ledge shall be calculated exactly. Rounding shall be to the nearest 1 cubic yard.

Quantities for structures that are supported on ledge shall be calculated exactly to the top of footing or reference plane for dimensions. The best information available shall be used for quantities below those planes. In the case that ledge excavation is called for on the plans, estimate to 6" below the minimum depth of footing called for.

Quantities estimated for items paid on a lump sum basis may be rounded as per design policy for rounding.

The volumes of mass pier shafts, abutments, or other elements with more than two battered faces should be calculated using the prismoidal formula as follows:

$V=h/6*(A_1+A_2+4*A_3)$

h=height of element.

A_1 & A_2 are the areas of the top and bottom, parallel surfaces.

A_3 is the area of a section cut at mid-height, parallel with the bases.

502 - Concrete Wearing Surface (LS/CY)

On new structures and other structures where the quantity of concrete can be accurately determined, payment for Structural Concrete Wearing Surface will be on a lump sum basis. Quantity shall be rounded to the nearest 1 c.y.

No separate payment will be made for the 1" Integral Concrete Wearing Surface, but payment will be made as part of the structural concrete slab.

503 - Reinforcing Steel (LB)

Quantities shall be calculated from the detailed schedule, using theoretical weights, per linear foot, and rounded to the nearest 100 pounds. A spreadsheet is available for calculating quantities. The results should be checked for agreement with the reinforcing schedule.

If precast deck panels are used, superstructure rebar is incidental to superstructure concrete and should not be included in the estimate.

> ⓘ **Results should be corrected for late changes in the schedule.**

504 - Structural Steel (LS/LB)

Theoretical weights shall be used for all structural steel computations. The extreme length of members shall be used. Weight of welds, bolts, and plate over run shall not be included. No deductions shall be made for any copes, cuts, clips, or bevels on any members. For haunched sections of welded girders, the average of the maximum and minimum depths of web shall be used. Weight of standard bearing pedestals shall be as listed in the Bridge Design Manual.

505 - Shear Connectors (LS/EA)

The total number as detailed on the plans shall be estimated without rounding. A 5" x 7/8" diameter stud shall be considered to weigh 1.0 pound for estimates only.

507 - Bridge Railing (LF)

The length as detailed on the plans, including rail overhang, shall be estimated and rounded to the nearest 1 foot.

When Type 3-Single Rail-Bridge Mounted rail is used, include Item 609.247 to pay for the precast concrete transition curb. Also, add 12.5 feet of Type 3 GR at each corner of the bridge to account for the nested beam and extra posts beyond the bridge mounted GR as per Standard Detail 606(20).

508 - Membrane Waterproofing (LS/SY)

The total deck area between curbs and between end dams shall be estimated with no allowance for membrane turned up at edges and no deduction for obstructions such as drains.

509 - Structural Plate Structures (LS/LB)

Overview

Structural plate pipes, plate pipe arches and plate arches are paid for by lump sum/pound and plate box culverts are paid for by lump sum. The difference is that the weight of a pipe, pipe arch and arch can be estimated using the plate thicknesses and lengths specified on the drawings and unit weights published in manufacturer's catalogs but the weight of box culverts can not because the plate thicknesses are designed by the manufacturer.

Multiple plates are required to create one ring of the structure. The curved length of each plate is in multiples of π. Why π? Remember the circumference of a pipe is equal to π times its diameter ($c = \pi * d$). For example, the circumference of a 60" diameter pipe is 60π. Thus it takes four 15π plates to construct a 60" diameter pipe ($4*15\pi = 60\pi$).

Steel structures typically use combinations of 9π, 15π, 18π, 21π and 24π plates to create the available plate structures. For example, a 7'-0" span by 5'-1" rise plate pipe arch with a peripheral length of 75π is constructed from two 9π, two 18π and one 21π plates ($2*9\pi + 2*18\pi + 21\pi = 75\pi$). The steel manufacturer's catalog details the location of each plate in the structure as bottom, top or corner.

Aluminum structures are slightly different and give plate arc lengths in terms of N instead of π where N is approximately equal to 3π. The circumference of a 60" diameter aluminum pipe is 20N ($20*3\pi = 60\pi$). Standard aluminum plate lengths are 8N, 9N, 10N, 11N, 12N, 13N and 14N. The longer plates result in fewer plates per ring. For example, a 6'-7" span by 5'-8" rise pipe arch with a total N of 25 (75π) is constructed from 2 plates compared to five plates in the above steel example. Thus to form the pipe arch shape, each aluminum plate will have multiple radii. Aluminum structures also use the nomenclature of invert, crown and haunch arc lengths instead of bottom, top and corner plates.

Other Considerations

- Typically aluminum structures use one plate thickness throughout but steel structures use two. The plates below ordinary high water are two sizes heavier for increased abrasion and corrosion protection. The plate thicknesses are specified in the Structural Plate Notes on the drawings.
- Use manufacturer's catalogs that include the weight of nuts and bolts in their unit weight tables.
- Reinforcement at the ends of aluminum structures is considered incidental to the pay item.
- Ignore skewed ends and use the centerline length of the structure in weight computations. The impacts of skewed ends are generally small in comparison to the total quantity.
- Do not include the weight of reinforcing ribs in the estimate of aluminum structures.

Example Estimate for an Aluminum Plate Pipe Arch

Given: 12'-11" span x 7'-6" rise aluminum plate pipe arch, 80' centerline length, 62'-6" top centerline length, 0.15" plates and 2'-6'" vertical step cut.

Step 1. From the *Pipe Arch Details Table* in a manufacturer's catalog:

Arc Length for crown = 17N, haunch = 7N and invert = 11N

Total = 42N

Crown arc length	1 x 17N =	17N
Haunch arc length	2 x 7N =	14N
Invert arc length	1 x 11N =	<u>11N</u>
		42N total peripheral length

<u>Assume</u> vertical cut occurs at the top of the 7N haunch arcs. The arc length of the vertical end cut is 11N+2(7N) = 25N.

Step 3 From the *Approximate Handling Weight of Structure Table* in a manufacturer's catalog:

Approximate Weight for 0.15"plates and 42N structure = 110 plf

Step 4	Weight of vertical cut invert and haunch plates = (25N)/42N * 110 plf *80'	= 5238#
	Weight of bevel cut crown plate = 17N/42N * 110 plf * (62.5'+80')/2	<u>= 3172#</u>
	Total weight of structure	= 8410#
Step 5	Rounding	
	Total weight of structure	= 8450#

Example Estimate for a Steel Plate Pipe Arch

Note: Typically in steel plate pipe arches with beveled ends the transition in plate sizes occurs at the top of corner plates. This example illustrates how to estimate the weight of a pipe arch for the slightly more complicated situation when the plate thickness transition occurs between top plates.

Given: 12'-6" span x 7'-11" rise steel plate pipe arch, 80' bottom centerline length, 62' top centerline length, the uppermost top plate shall be 0.138" thick, all other plates shall be 0.188" thick and 2'-8' vertical step cut.

Step 1. From the *Plate Arrangement and Approximate Weight per foot for Multi-Plate Pipe-Arch Table* in a manufacturer's catalog:

Corner Plate	2 x 9π =	18π
Bottom Plate	1 x 18π =	18π
Bottom Plate	1 x 21π =	21π
Top Plate	1 x 21π =	21π (0.138" plate)
Top Plate	2 x 24π =	48π
	7 total	126π total peripheral length

Approximate weight for 0.138" plate structure = 277plf

Approximate weight for 0.188" plate structure = 373plf

Step 2. From the *Multi-Plate Pipe-Arch Table* in a manufacturer's catalog,

Radius of top plates = 76"

B, vertical distance to top of corner plates = 2'-8" (Note for pipe arches the manufacturer recommends locating the vertical step cut at the top of the corner plates)

Step 3. Determine length of beveled cut plates

Total height of bevel cut = 7'-11" – 2'-8" = 5'-3"

Total length of bevel cut = (80'-62')/2 = 9'-0"

Height of top plate in bevel cut, $h = r - r*\cos[(s/2r)*(360/2\pi)]$, where

r = radius of top plate

s = arc length

$360/2\pi$ = Conversion factor from radians to degrees

h = 76" – 76" cos [(21π/2*76")*(360/2π)] = 7.05" or 0.5873'

Length of top plate in bevel cut = (9'-0"/5'-3")* 0.5873' = 1.0'

Overall length of top plate = 62' + 2*1.0' = 64'

Step 4. Weight of 21π top plate = 21π/126π * 277plf * (62'+64')/2 = 2,909#

Weight of 24π top plates =(24π+24π) /126π * 373plf * (64'+80')/2 = 10,231#

Weight of corner and bottom plates = (18π+18π+21π) /126π * 373plf *80' = 13,499#

	Total weight of structure	= 26,638#
Step 5	Rounding	
	Total weight of structure	= 26,700#

511 - Cofferdams (EA)

Where cofferdams are required there shall be a cofferdam pay item for each substructure unit within a bridge or rigid frame. A concrete box culvert with a bottom slab shall be considered to have one substructure unit. A cofferdam unit is to be included for structural plate pipes and structural plate pipe arches when applicable.

513 - Slope Protection (SY)

Slope protection is generally fully detailed on the plans. Areas should be rounded to the nearest 1 square yard.

526 – Temporary Concrete Barriers (LF or LS/LF)

Use 526.301 (LS) for multiple moves of temporary barrier, such as staged construction. Use 526.30 (LF) for one placement, such as road closing.

603 - Culverts (LF)

Quantity shall be the total called for on the plans. Total for each size and type should, in general, be in multiples of 2 feet. Do not round unless the actual quantity is indeterminate.

606 - Guardrail (LF)

Total shall be as called for on the plans. Beam guardrail shall be in multiples of 12.5 feet, to the nearest 1 foot.

606 - Low Volume Guardrail End (EA)

Terminal ends are included in Item 606.78 and are not a separate pay item.

618 - Seeding (UN)

Rules of Thumb

Seeding, Method No. 2 is used for all seeding except for areas that are to be mowed regularly. This type seeding should also be specified for mowed areas when the area is less than 20 percent of the total seeding requirement.

Seeding should be estimated for all cut and fill slopes, including toe fills, from the edge of shoulder to the toe of fill or top of cut except that no seeding shall be estimated for ledge slopes shown on a 1/4:1 slope, and riprapped areas.

In addition to the above described quantity, on rural projects an additional 5 feet width shall be added to all Method No. 2 areas to provide for additional disturbed areas beyond the slope lines and the unavoidable extra areas seeded.

The quantity of these items is to be estimated as measured along the slope of the finished ground in units of 1,000 square feet.

Calculating Side Slope Area

Areas as measured on the plan need to be increased to account for the slope of the ground to be seeded. Use the following factors at the side slopes specified:

1:4	1.031
1:3	1.054
1:2.5	1.077
1:2	1.118
1:1.75	1.152

619 - Mulch, Erosion Control Mix

Mulch is used on all seeded areas.

No deduction in the estimated quantity shall be made for small areas of sod or erosion control mesh used in ditches, etc., since these will be unavoidably mulched with the remainder of the slopes.

Estimate one Unit of Mulch (Item 619.1201) for each Unit of Seeding.

When loam and seed cannot be applied at project completion and erosion control must be provided over a winter, estimate 2 CY of Erosion Control Mix (Item 619.1401) for each CY of Loam.

627 – Pavement Markings

The accepted quantity of permanent pavement marking lines will be paid for at the contract unit price per foot.

When estimating for temporary traffic control items on bridge projects be sure to compensate for removal of existing striping, temporary striping, and re-striping the approaches where traffic lanes are temporarily changed.

629, 631 - Labor And Equipment Items (HR)

Do not show labor and equipment rental items on any project (in the estimate or on quantity sheet) unless some work is specifically spelled out on the contract plans which is to be paid for by specific labor and equipment rental items. Since Contractors frequently unbalance the bid prices on labor equipment items, in anticipation of large overruns on these items, it may be advisable to default to the "Blue Book" prices even when there is work that could be paid for by specific labor and equipment rental items. Group Leaders will decide on the best method to use in each individual case.

637 - Dust Control (LS)

This item should be included when traffic will be maintained on unpaved roadway in close proximity to businesses or dwellings in waterway crossing projects.

652 - Work Zone Traffic Control (LS)

Item 526.301, Temporary Concrete Barrier Type 1, Item 643.72 Temporary Traffic Signal and Item 652.38, Flagger are not included in this item and must be paid separately. Type I, II, and III barricades are included in this item and do not need to be paid for separately.

652 - Maintenance Of Traffic Items

For each project a Traffic Control Plan shall be requested from the Engineer of Traffic and the appropriate pay items shall be included in the estimate. Special detours shall be used where applicable.

656 - Temp. Soil Erosion and Pollution Control (LS)

Erosion control is paid for lump sum.

659 - Mobilization (LS)

This item is to be used on all projects to allow payment to a Contractor for establishing himself on the project. Typical cost will be 5 percent to 6 percent of the projects estimated cost.

10.3 Sample Item Lists

Simple Span, Precast, Prestressed Voided Slab on Integral Abutments

Item #	Description	Units
202.19	Removing Existing Bridge	LS
203.20	Common Excavation	m^3
203.24	Common Borrow	m^3
203.25	Granular Borrow	m^3
204.41	Rehab Of Existing Shoulders, Plan Qty	m^2
206.082	Str Earth Excavation-Major Structures	m^3
304.10	Aggregate Subbase Course - Gravel	m^3
403.208	Hot Mix Asphalt, 12.5 mm, Surface	Mg
403.210	Hot Mix Asphalt, 9.5 mm	Mg
403.213	Hot Mix Asphalt 12.5 mm Nominal Max. Size, Base	Mg
409.15	Bituminous Tack Coat, Applied	L
501.231	Dynamic Loading Test	EA
501.46	Steel H-Beam Piles 109 kg/m, Delivered	m
501.461	Steel H-Beam Piles 109 kg/m, In Place	m
501.90	Pile Tips	EA
501.92	Pile Driving Equipment Mobilization	LS
502.21	Structural Concrete Abuts & Ret Walls	m^3
502.25	Str Conc Superstr Slab	LS
502.49	Structural Concrete Curbs and Sidewalks	LS
503.12	Reinforcing Steel, Fab & Del	kg
503.13	Reinforcing Steel, Placing	kg
508.13	Membrane Waterproofing	LS
510.10	Special Detour, 4.8 m Roadway Width	LS
511.07	Cofferdam: Abutment No. 1	LS
511.07	Cofferdam: Abutment No. 2	LS
512.081	French Drains	LS
514.06	Curing Box for Concrete Cylinders	EA
515.21	Protective Coating for Concrete Surfaces	LS
526.301	Temporary Concrete Barrier Type I	LS
535.60	Prestressed Str Conc Slab	LS
604.18	Adjust Manhole Or Cb To Grade	EA

606.35	Guardrail Delineator Post	EA
606.55	Guardrail Type 3 - Single Rail	m
606.74	Gr Tp 3 - Single Rail Bridge Mounted	m
606.78	Low Volume Guardrail End - Type 3	EA
609.247	Terminal Curb Type 2 - 2.1 m	EA
610.08	Plain Riprap	m^3
610.16	Heavy Riprap	m^3
613.319	Erosion Control Blanket	m^2
615.07	Loam	m^3
618.1411	Seeding Method Number 3 - Plan Quantity	UN
619.1201	Mulch - Plan Quantity	UN
619.1301	Bark Mulch - Plan Quantity	UN
620.58	Erosion Control Geotextile	m^2
622.10	Transplanting Shrub	EA
627.711	White or Yellow Pvt Marking Line - Plan Quantity	m
627.76	Temp Pvt Marking Line, White or Yellow	LS
629.05	Hand Labor, Straight Time	MH
631.12	All-Purpose Excavator (Inc Operator)	HR
631.14	Grader (Including Operator)	HR
631.15	Roller Earth Base Crs (Inc Op)	HR
631.172	Truck-Large (Inc Operator)	HR
631.22	Front End Loader (Inc Oper)	HR
637.071	Dust Control	LS
639.19	Field Office Type B	EA
652.312	Type III Barricade	EA
652.39	Work Zone Traffic Control	LS
656.75	Temp. Soil Erosion and Pollution Control	LS
659.10	Mobilization	LS

Low Profile Steel Box Culvert

Item #	Description	Units
203.20	Common Excavation	m^3
203.24	Common Borrow	m^3
203.25	Granular Borrow	m^3

204.41	Rehab Of Existing Shoulders, Plan Qty	m^2
206.061	Str Earth Excavaion Below Grade Str	m^3
304.10	Aggregate Subbase Course - Gravel	m^3
403.208	Hot Mix Asphalt, 12.5 mm	Mg
403.213	Hot Mix Asphalt 12.5 mm Nominal Max. Size, Base	Mg
409.15	Bituminous Tack Coat, Applied	l
509.43	Metal Structural Plate Box Culvert	LS
510.10	Special Detour, 4.6 m Roadway Width	LS
511.07	Cofferdam: Upstream	LS
511.07	Cofferdam: Downstream	LS
526.301	Temporary Concrete Barrier Type I	LS
606.265	Terminal End- Single Rail- Galv Steel	EA
606.35	Guardrail Delineator Post	EA
606.55	Guardrail Type 3 - Single Rail	m
606.60	Guardrail Type 3 - Over 4.5 m Radius	m
606.76	Modified Eccentric Loader Terminal	EA
610.08	Plain Riprap	m^3
613.319	Erosion Control Blanket	m^2
615.07	Loam	m^3
618.1411	Seeding Method Number 3, Plan Quantity	UN
619.1201	Mulch - Plan Quantity	UN
620.54	Stabilization/Reinforcement Geotextile	m^2
620.58	Non-woven Geotextile	m^2
627.711	White or Yellow Pavement Marking Line, Plan Quantity	m
629.05	Hand Labor, Straight Time	MH
631.12	All-Purpose Excavator (Inc Operator)	HR
631.14	Grader (Including Operator)	HR
631.15	Roller Earth Base Crs (Inc Op)	HR
631.171	Truck-Small (Inc Operator)	HR
637.071	Dust Control	LS
639.19	Field Office Type B	EA
652.39	Work Zone Traffic Control	LS
656.75	Temp. Soil Erosion and Pollution Control	LS
659.10	Mobilization	LS

Two Span, Precast, Prestressed Butted Box Beams on Deep Abutments and Mass Pier

Item #	Description	Unit
202.19	Removing Existing Bridge	LS
203.20	Common Excavation	m³
203.24	Common Borrow	m³
203.25	Granular Borrow	m³
206.082	Str Earth Excavation-Major Structures	m³
206.092	Str Rk Exc- Major Structures	m³
206.10	Str Earth Exc - Piers	m³
206.11	Str Rock Exc - Piers	m³
304.10	Aggregate Subbase Course - Gravel	m³
403.209	Hot Mix Asphalt, 9.5 mm(Swks, etc.)	Mg
403.210	Hot Mix Asphalt, 9.5 mm	Mg
403.213	Hot Mix Asphalt 12.5 mm Nominal Max. Size, Base	Mg
409.15	Bituminous Tack Coat, Applied	l
502.21	Structural Concrete Abuts & Ret Walls	m³
502.22	Str Conc Abut & Ret Wall Uw	m³
502.23	Structural Concrete Piers	m³
502.24	Str Conc Piers Uw	m³
502.25	Str Conc Superstr Slab	LS
502.31	Structural Concrete Approach Slab	LS
502.49	Structural Concrete Curbs and Sidewalks	LS
503.12	Reinforcing Steel, Fab & Del	kg
503.13	Reinforcing Steel, Placing	kg
508.14	High Performance Membrane Waterproofing	LS
510.11	Spec Det Ped Tr Only	LS
511.07	Cofferdam: Abutment No. 1	LS
511.07	Cofferdam: Abutment No. 2	LS
511.07	Cofferdam: Pier	LS
512.081	French Drains	LS
514.06	Curing Box for Concrete Cylinders	EA
515.21	Protective Coating for Concrete Surfaces	LS
526.323	Texas Classic Rail	LS
535.62	Prestressed Str Conc Box Beam	LS

603.169	375 mm Culvert Pipe Option III	m
603.179	450 mm Culvert Pipe Option III	m
604.072	Catch Basin Type A1-C	EA
604.164	Rebuilding Catch Basin	EA
606.172	Bridge Transition Type 1	EA
606.18	Gr Tp 3b - Double Rail	m
606.265	Terminal End- Single Rail- Galv Steel	EA
606.35	Guardrail Delineator Post	EA
606.55	Guardrail Type 3 - Single Rail	m
606.59	Gr Tp 3 -4.5m Radius & Less	m
606.76	Modified Eccentric Loader Terminal	EA
609.11	Vert Curb Type 1	m
609.237	Terminal Curb Type 1 - 2.1 m	EA
610.08	Plain Riprap	m^3
610.09	Hand Laid Riprap	m^3
613.319	Erosion Control Blanket	m^2
615.07	Loam	m^3
618.1301	Seeding Method Number 1, Plan Quantity	UN
618.1411	Seeding Method Number 3, Plan Quantity	UN
619.1201	Mulch - Plan Quantity	UN
619.1401	Erosion Control Mix	m^3
620.58	Erosion Control Geotextile	m^2
627.711	White or Yellow Pvt. Marking Line, Plan Quantity	m
629.05	Hand Labor, Straight Time	MH
631.12	All-Purpose Excavator (Inc Operator)	HR
631.14	Grader (Including Operator)	HR
631.15	Roller Earth Base Crs (Inc Op)	HR
631.172	Truck-Large (Inc Operator)	HR
631.22	Front End Loader (Inc Oper)	HR
635.14	Prefabricated Concrete Modular Gravity Wall	m^2
637.071	Dust Control	LS
639.18	Field Office Type A	EA
643.72	Temporary Traffic Signal	LS
652.361	Maint Of Traff Control Dev	LS
652.38	Flagger	MH

652.39	Work Zone Traffic Control	LS
656.75	Temp. Soil Erosion and Water Pollution Control	LS
659.10	Mobilization	LS
660.21	On-The-Job Training (Bid)	MH
845	Structural Steel Utility Support (Portland Water Disctrict)	LS

Deck Replacement

Item #	Description	Unit
202.10	Rem Exist Superstrs Prop Contr	LS
202.12	Rem Exist Structural Concrete	m^3
203.20	Common Excavation	m^3
304.10	Aggregate Subbase Course - Gravel	m^3
403.210	Hot Mix Asphalt, 9.5 mm	Mg
403.213	Hot Mix Asphalt 12.5 mm Nominal Max. Size, Base	Mg
409.15	Bituminous Tack Coat, Applied	l
502.219	Struc Conc, Abut & Ret Wall	LS
502.26	Str Concrete Rd&Sw Slab On Steel Bridges	LS
503.12	Reinforcing Steel, Fab & Del	kg
503.13	Reinforcing Steel, Placing	kg
503.14	Epoxy Coat Rein Steel Fab&Del	kg
503.15	Epoxy Coat Rein Steel Plac	kg
503.17	Mechanical Welded Splice	EA
505.08	Shear Connectors	LS
507.0848	Barrier Mounted Steel Bridge Rail, 2 Bar	LS
508.13	Membrane Waterproofing	LS
515.21	Protective Coating for Concrete Surfaces	LS
521.23	Exp Device - Finger Joint	EA
521.41	Fabric Curtain - Finger Joint	EA
523.07	Elastomeric Bridge Bearing - Laminated	EA
526.301	Temporary Concrete Barrier Type I	LS/m
526.321	Permanent Concrete Barrier Type IIIA	m
606.15	Gr Tp 3a - Sgl Rail	m
606.1721	Bridge Transition Type 1	EA
606.36	Gr Removed And Reset	m

615.07	Loam	m^3
617.30	Composted Bark Mix	m^3
618.1411	Seeding Method Number 3 - Plan Quantity	UN
618.15	Temporary Seeding	kg
618.25	Applied Water	m^3
629.05	Hand Labor, Straight Time	MH
631.12	All-Purpose Excavator (Inc Operator)	HR
631.132	Small Bulldozer (Inc Operator)	HR
631.14	Grader (Including Operator)	HR
631.15	Roller Earth Base Crs (Inc Op)	HR
631.172	Truck-Large (Inc Operator)	HR
637.071	Dust Control	LS
639.18	Field Office Type A	EA
645.13	Guide Sign - Overpass Mounted	LS
652.33	Drum	EA
652.34	Cone	EA
652.39	Work Zone Traffic Control	LS
656.75	Temp. Soil Erosion and Pollution Control	LS
659.10	Mobilization	LS

10.4 Rounding

Quantity Types

There are two types of quantities, quantities arrived at by counting (trees, catch basins, single posts, etc.) and quantities arrived at by calculations (excavation, portland cement concrete and summation of linear footage such as guardrail and culvert pipe.)

Counted Items

For counted items, the estimated quantity shall be the actual total count as taken from the plans.

Rounding Calculated Items

For calculated quantities the following rules shall apply (except as provided in Rounding Exceptions, section 0.5, below).

A. Total quantities less than 1.0 may be rounded upward not more than 0.1 unit.

B. Total quantities of 1 and over and less than 10 may be rounded upward not more than 0.5 unit.

C. Total quantities of 10 and over and less than 100 may be rounded upward not more than 1 unit.

D. Total quantities of 100 and over and less than 1,000 may be rounded upward not more than 10 units.

E. Total quantities of 1,000 and over and less than 10,000 may be rounded upward not more than 50 units.

F. Total quantities over 10,000 shall be rounded to the nearest third significant figure.

Rounding Exceptions

A. Structural Concrete quantities, when not on ledge rock, shall be rounded to the nearest 1 cubic yard.

B. Reinforcing steel quantities shall be rounded to the nearest 100 pounds.

C. Bridge Railing and Vertical Bridge Curb quantities shall be rounded to the nearest 1 linear foot.